

# AERONAUTICAL ENGINEERING

A CONTINUING BIBLIOGRAPHY WITH INDEXES

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Each entry in the publication consists of a standard bibliographic citation accompanied, in most cases, by an abstract.

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Two indexes—subject and author are included after the abstract section.

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# Typical Report Citation and Abstract

- ❶ 19970001126 NASA Langley Research Center, Hampton, VA USA
- ❷ **Water Tunnel Flow Visualization Study Through Poststall of 12 Novel Planform Shapes**
- ❸ Gatlin, Gregory M., NASA Langley Research Center, USA Neuhart, Dan H., Lockheed Engineering and Sciences Co., USA;
- ❹ Mar. 1996; 130p; In English
- ❺ Contract(s)/Grant(s): RTOP 505-68-70-04
- ❻ Report No(s): NASA-TM-4663; NAS 1.15:4663; L-17418; No Copyright; Avail: CASI; A07, Hardcopy; A02, Microfiche
- ❼ To determine the flow field characteristics of 12 planform geometries, a flow visualization investigation was conducted in the Langley 16- by 24-Inch Water Tunnel. Concepts studied included flat plate representations of diamond wings, twin bodies, double wings, cutout wing configurations, and serrated forebodies. The off-surface flow patterns were identified by injecting colored dyes from the model surface into the free-stream flow. These dyes generally were injected so that the localized vortical flow patterns were visualized. Photographs were obtained for angles of attack ranging from 10° to 50°, and all investigations were conducted at a test section speed of 0.25 ft per sec. Results from the investigation indicate that the formation of strong vortices on highly swept forebodies can improve poststall lift characteristics; however, the asymmetric bursting of these vortices could produce substantial control problems. A wing cutout was found to significantly alter the position of the forebody vortex on the wing by shifting the vortex inboard. Serrated forebodies were found to effectively generate multiple vortices over the configuration. Vortices from 65° swept forebody serrations tended to roll together, while vortices from 40° swept serrations were more effective in generating additional lift caused by their more independent nature.
- ❽ Author
- ❾ *Water Tunnel Tests; Flow Visualization; Flow Distribution; Free Flow; Planforms; Wing Profiles; Aerodynamic Configurations*

## Key

1. Document ID Number; Corporate Source
2. Title
3. Author(s) and Affiliation(s)
4. Publication Date
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# AERONAUTICAL ENGINEERING

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*A Continuing Bibliography (Suppl. 404)*

JULY 9, 1999

## 01 AERONAUTICS

**19990046095** Society of Experimental Test Pilots, Lancaster, CA USA

**1997 Report to the Aerospace Profession: Forty First Symposium Proceedings**

Forty First Symposium Proceedings; Sep. 1997; ISSN 0742-3705; 454p; In English; Report to the Aerospace Profession, 25-27 Sep. 1997, Beverly Hills, CA, USA; Sponsored by Society of Experimental Test Pilots, USA; See also 19990046096 through 19990046114; Copyright; Avail: Issuing Activity (Society of Experimental Test Pilots, Lancaster, CA), Hardcopy, Microfiche

The objectives of these proceedings contain the following: Promote air safety by presenting pilot's opinion; Strengthen the influence of the test pilot on aeronautical progress; Continuously evaluate the adequacy of flight equipment; Exchange information for the development of improved testing techniques; Exchange ideas, experiences, and information concerning techniques of escape and survival; Discuss newly experienced phenomena in the realm of flight; Further professional advancement through lectures and displays-, Stimulate interest in aviation careers through scholarships and other projects among the youth of the world; Broaden professional and fraternal relationships.

Author

*Conferences; Aircraft Safety; Test Pilots; Survival*

**19990046200** NASA Langley Research Center, Hampton, VA USA

**Aeronautical Engineering: A Continuing Bibliography with Indexes, Supplement 402**

Jun. 11, 1999; 45p; In English

Report No.(s): NASA/SP-1999-7037/Suppl402; NAS 1.21:7037/Suppl402; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

This report lists reports, articles and other documents recently announced in the NASA STI Database.

Author

*Data Bases; Bibliographies; Indexes (Documentation); Aeronautical Engineering*

**19990046347** Research and Technology Organization, Applied Vehicle Technology Panel, Neuilly-sur-Seine, France

**Exploitation of Structural Loads/Health Data for Reduced Life Cycle Costs** *Exploitation des Données Relatives aux Efforts Structuraux et à l'Intégrité des Structures en vue de la Diminution des Coûts Globaux de Possession*

Exploitation of Structural Loads/Health Data for Reduced Life Cycle Costs; November 1998; 252p; In English, 11-12 May 1998, Brussels, Belgium; See also 19990046348 through 19990046366

Report No.(s): RTO-MP-7; AC/323(AVT)TP/4; ISBN 92-837-1005-3; Copyright Waived; Avail: CASI; A12, Hardcopy; A03, Microfiche

Contains the papers presented at a Specialists' Meeting on Exploitation of Structural Loads/Health Data for Reduced Life Cycle Costs, organized by the Applied Vehicle Technology Panel (AVT) of RTO, in Brussels, Belgium, 11-12 May 1998. The papers highlight the potential benefits from the exploitation of the information derived from modern and future monitoring systems in terms of improved airworthiness and preventative maintenance. The meeting concentrated on the collection, analysis and use of loads/health data by the military for fleet maintenance and logistics planning. Systems and techniques for data gathering and automated analysis were described by authors from a number of NATO nations to provide a valuable insight into how such systems contribute to reducing life cycle costs of military hardware. The papers are presented under the following headings: Current and future structural monitoring; Engine/helicopter hums; Current military/civil experience; Monitoring systems and analysis.

Author

*Logistics; Loads (Forces); Life Cycle Costs; Health; Aircraft Reliability; Conferences; Maintenance*

**19990046348** Industrieranlagen-Betriebsgesellschaft m.b.H., Ottobrunn, Germany

**Requirements on Future Structural Health Monitoring Systems**

Neumair, M., Industrieranlagen-Betriebsgesellschaft m.b.H., Germany; Exploitation of Structural Loads/Health Data for Reduced Life Cycle Costs; November 1998; 10p; In English; See also 19990046347; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

Due to the higher structural complexity of combat aircraft the time and costs for inspections and modifications are increasing. For economic and operational reasons, it is more and more important to carry through a modern aircraft maintenance and life extension program, which directly depends on the individual in service usage of combat aircraft. As a result of the rapid progress in the development and production of new powerful data acquisition units, the use of complex onboard structural health monitoring systems for each individual aircraft, which directly monitors the point of time for inspections and modifications for life extension programs, is the future of economic maintenance. This paper provides an overview of the experiences with previous and existing in-service life monitoring systems, i.e. the OLMOS system of TORNADO. Based on this experience the hard- and software requirements for a new in-service structural health monitoring system, which is necessary for an economic usage of combat aircraft, will be discussed within the scope of the actual technical and operational limits. Due to such complex structural health monitoring systems, rearrangements are necessary in planning and carrying out depot maintenance. This paper will point out some important alterations.

Author

*Service Life; Health; Monitors; Complex Systems; Costs; Inspection*

**19990046349** Royal Air Force, Wyton, UK

**Future Fatigue Monitoring Systems**

Armitage, Steve R., Royal Air Force, UK; Holford, Dorothy M., Defence Evaluation Research Agency, UK; November 1998; 14p; In English; See also 19990046347; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

The RAF, in common with most of today's air forces, operates a wide range of aircraft, of varying sizes, roles and ages. At the one extreme, the Canberra fleet is now 50 years old and still providing sterling service in the photo-recce role. At the other extreme, Harrier II has been in service for 10 years, and has proven itself to be a highly capable ground-attack fighter. Moreover, EF2000, Nimrod 2000 and C-130J are all due to enter service within the next 5 years or so. The operation of all of our fleets has been underpinned by the close monitoring of fatigue, the aims of which have been to improve the management of structural integrity and to ensure that we can safely operate our aircraft up to their design lives. Despite advances in aircraft technology, our fatigue monitoring effort continues to rely upon some relatively aged equipment, with correspondingly aged analysis techniques. In recent years, advances in IT and data processing have revolutionized the aircraft designer's ability to install onboard sensors and systems, and the software designer's ability to generate compact and rapid airborne and ground-based processing equipment. The RAF is now looking closely at the procurement of state-of-the-art fatigue monitoring and processing equipment, and the formulation of a strategy by which such equipment can be adapted for use across as many fleets as require it. This paper will review the RAF's current fatigue monitoring effort and the emerging systems, with particular reference to Harrier II's Fatigue Monitoring and Computing System (FMCS) and EF2000's Structural Health Monitoring (SHM) system. Finally, future system requirements and options will be. Although the paper's emphasis is firmly upon fixed-wing aircraft systems, some consideration will be given to emerging helicopter Fatigue Usage Monitoring Systems (FUMS). FUMS is a development of Health and Usage Monitoring Systems (HUMS), currently being introduced into MOD service.

Author

*Airborne Equipment; Health; Structural Failure; Computer Systems Programs; Fatigue Life; Monitors*

**19990046351** National Defence Headquarters, Directorate Technical Airworthiness, Ottawa, Ontario Canada

**CF-188 Fatigue Life Management Program**

Caron, Y., National Defence Headquarters, Canada; Richard, Yves, Bombardier, Inc., Canada; November 1998; 12p; In English; See also 19990046347; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

The Canadian CF-188 Fatigue Life Management Program (FLMP) has been in place for over 10 years. This program has been successful in controlling fatigue accumulation on the CF-188 airframe. This had a major impact on the life cycle management cost of the aircraft. The solutions to the challenges encountered operating this program will be discussed. Lessons learned are summarized.

Author

*Fatigue Life; Airframes; Management Planning*

## 02 AERODYNAMICS

*Includes aerodynamics of bodies, combinations, wings, rotors, and control surfaces; and internal flow in ducts and turbomachinery.*

**19990045849** European Organization for the Safety of Air Navigation, Bretigny-sur-Orge France

### **User Manual for the Base of Aircraft Data (BADA). Revision 3.1**

Baulleret, P.; Nov. 1998; 108p; In English

Report No.(s): PB99-136178; EEC/NOTE-25/98; Copyright; Avail: National Technical Information Service (NTIS), Microfiche

The Base of Aircraft Data (BADA) provides a set of ASCII files containing performance and operating procedure coefficients for 151 different aircraft types. The coefficients include those used to calculate thrust, drag, and fuel flow and those used to specify nominal cruise, climb and descent speeds. The Manual for Revision 3.1 of BADA provides definitions of each of the coefficients and then explains the file formats. Instructions for remotely accessing the files via Internet are also given.

NTIS

*Aircraft Models; User Manuals (Computer Programs); Real Time Operation; Flight Operations; Aircraft Performance; Data Bases*

**19990045850** European Organization for the Safety of Air Navigation, Bretigny-sur-Orge France

### **Study of the Acquisition of Data from Aircraft Operations to Aid Trajectory Prediction Calculation**

Mykoniatis, G.; Martin, P.; Sep. 1998; 112p

Report No.(s): PB99-136152; EEC/NOTE-18/98; Copyright; Avail: National Technical Information Service (NTIS), Microfiche

Several aircraft operators were consulted to determine if they could supply flight data to ATS which would make a significant difference to the trajectories calculated by flight data processing systems, particularly in the initial climb phase. In parallel, simulations were carried out using a typical trajectory prediction simulator to assess the benefits which might be obtained from this data. The study then went on to investigate when and how this data could be supplied.

NTIS

*Data Acquisition; Flight Operations; Data Processing; Trajectory Planning*

**19990045881** Defence Science and Technology Organisation, Aeronautical and Maritime Research Lab., Melbourne, Australia

### **Survey on the Aerodynamics of Battle-Damaged Combat Aircraft**

Erm, Lincoln P.; Defence Science and Technology Organisation, Australia; June 1998; 11p; In English; Original contains color illustrations

Report No.(s): DSTO-GD-0184; DODA-AR-010-563; Copyright; Avail: Issuing Activity (DSTO Aeronautical and Maritime Research Lab., PO Box 4331, Melbourne, Victoria 3001, Australia), Hardcopy, Microfiche

A literature survey on the aerodynamics of battle-damaged combat aircraft is presented in this report. The survey considers experimental investigations carried out in wind tunnels using either scaled or full-sized models of complete aircraft or components of aircraft that have either simulated damage or actual gunfire damage. The survey could assist in the planning of a possible experimental program at AMRL to obtain aerodynamic data for battle-damaged aircraft. The data could be used in modelling the flight-dynamic behaviour of damaged aircraft.

Author

*Aerodynamics; Damage; Fighter Aircraft; Experimentation; Surveys*

**19990045972** DYNACS Engineering Co., Inc., Brook Park, OH USA

### **Highlights of Aeroacoustics Research in the U.S. 1998**

Raman, Ganesh, DYNACS Engineering Co., Inc., USA; McLaughlin, Dennis K., Pennsylvania State Univ., USA; March 1999; 20p; In English; Aeroacoustics, 10-12 May 1999, Seattle, WA, USA; Original contains color illustrations

Contract(s)/Grant(s): NAS3-98008; RTOP 530-03-11

Report No.(s): NASA/CR-1999-208888; NAS 1.26:208888; E-11632; AIAA Paper 99-1915; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

Highlights of aeroacoustics research in the USA of America during 1998 are reported in a summary compiled from information provided by members of the Aeroacoustics Technical Committee of the American Institute of Aeronautics and Astronautics (AIAA) and other leading research groups in industry, national laboratories, and academia. The past few years have seen significant progress in aeroacoustics. Research has steadily progressed toward enhanced safety, noise benefits, and lower costs. Since industrial progress is generally not published in the archival literature, it is particularly important to highlight these accomplishments. This year we chose to report on five topics of great interest to the aerospace industry including a synopsis of fundamental

research at universities and national laboratories. The topics chosen are: (1) Advanced Subsonic Technology (AST), (2) High Speed Research (HSR), (3) Rotorcraft, (4) Weapons bay aeroacoustics control and (5) Academic research including Computational AeroAcoustics (CAA). Although the information presented in this review is not all encompassing we hope that the topics covered will provide some insights into aeroacoustics activity in the U.S.

Author

*Research; Aeroacoustics; Subsonic Speed; Rotary Wing Aircraft; Progress*

**19990046091** National Aerospace Lab., Tokyo Japan

**Releasing, Approach and Landing Results of the ALFLEX First Landing Trial**

May 1998; 42p; In English

Report No.(s): PB99-141491; NAL-TR-1352T; Copyright; Avail: National Technical Information Service (NTIS), Microfiche

The flight experiment of the ALFLEX (Automatic Landing Flight Experiment) vehicle, a scaled model of HOPE, was conducted to establish unmanned guidance, navigation and control technologies for automatic landing of HOPE. The first landing of the ALFLEX vehicle was made on July 6, 1996 followed by 12 more landings until August 15, 1996. This first landing was achieved after a series of hanging flight trials with a helicopter that confirmed the vehicle functions and calibrated the sensors. Also, prior to these flight tests in Australia, hanging flights had been repeated in Japan as preliminary tests. to provide examples of the experiences and lessons from the unmanned landing tests, this report summarizes the detailed procedures, results and problems with the first landing trial, which has yielded useful results.

NTIS

*Flight Tests; Approach Control; Automatic Landing Control; Approach; Helicopters*

**19990046425** Naval Postgraduate School, Monterey, CA USA

**Stability and Control Module for Joint Army/Navy Rotorcraft Analysis and Design (JANRAD) Software and Graphical User Interface (GUI)**

Heatborn, David A.; Mar. 1999; 268p; In English

Report No.(s): AD-A361823; No Copyright; Avail: CASI; A12, Hardcopy; A03, Microfiche

The Joint Army/Navy Rotorcraft Analysis and Design (JANRAD) computer program has been developed at the Naval Postgraduate School to aid in the preliminary design of rotorcraft and has been updated to include a Graphical User Interface (Gul). This thesis is a continuation of the program focusing on stability and control analysis. The trim solution for a specified flight condition is computed from the Performance module of the program. This trim solution is then used to compute stability derivatives for the specified flight condition and a linear state space model is created. This solution can then be used to perform various time and frequency domain analyses or can be saved to a file for future use.

DTIC

*Flight Control; Aerodynamic Stability; Graphical User Interface; Aircraft Design; Flight Conditions*

**19990046426** Naval Postgraduate School, Monterey, CA USA

**Modeling the Coupled Rotor/Fuselage Response of the H-3 Sea King Utilizing the NPS Full Nonlinear Response**

Rafanello, Salvatore P.; Mar. 1999; 93p; In English

Report No.(s): AD-A361824; No Copyright; Avail: CASI; A05, Hardcopy; A01, Microfiche

Adapting the Naval Postgraduate School full nonlinear simulation model of coupled rotor/fuselage response to the 11-3 Sea King, the concentration of this work rests on validating the rotor simulation against an actual rotorcraft. The parameters of the 11-3 from the characteristic equation of a modeled mass-spring- damper system are inputted into a five-bladed model initially utilizing MAPLE to process LaGrange's equation defining the helicopter's full set of nonlinear equations of motion. Results are converted to MATLAB and are then processed in SIMULINK returning time history plots of blade/fuselage motion. Conclusions are in accordance with literature of Coleman, Fein old and Deutsch.

DTIC

*Computerized Simulation; Fuselages; Rotary Wing Aircraft; Eigenvectors; Rotary Wings*

**19990046427** Naval Surface Warfare Center, Dahlgren Div., Dahlgren, VA USA

**A Simplified Method for Predicting Aerodynamics of Multi-Fin Weapons Final Report**

Moore, Frank G.; McInville, Roy M.; Robinson, David I.; Mar. 1999; 78p; In English

Report No.(s): AD-A361829; NSWCDD/TR-99/19; No Copyright; Avail: CASI; A05, Hardcopy; A01, Microfiche

A new semiempirical method was developed to compute aerodynamics of multi-fin missile configurations using cruciform missile aerodynamics as a baseline. The method was developed using full Euler Computational Fluid Dynamics codes to compare

computations with wind tunnel data bases for cruciform missiles as a function of Mach number, angle of attack, and aspect ratio. The Euler codes were then used for the same free stream conditions and missile configurations except the number of fins were increased from four to six and eight respectively. A table of coefficients was then formed for the aerodynamics of six- and eight-fin configurations compared to that of four-fin cases for use in the aeroprediction code or other semiempirical codes. It was concluded that this approach worked well except for subsonic Mach numbers at moderate to large angles of attack, where the Euler codes failed to predict the leeward plane flow field adequately. It is believed that full Navier-Stokes solutions could be used to improve upon this semiempirical model. Engineering judgement, in conjunction with low angle-of-attack Euler solutions were used in the regions where Euler solutions were suspect. In comparing the new semiempirical method to a limited amount of wind tunnel data on several configurations, it was concluded that the model worked well at all the conditions where data was available. However, additional wind tunnel data at higher angles of attack on six- and eight-fin configurations is needed before the method can be truly validated.

DTIC

*Aerodynamic Configurations; Missile Configurations; Aerodynamic Characteristics*

### 03

## AIR TRANSPORTATION AND SAFETY

*Includes passenger and cargo air transport operations; and aircraft accidents.*

**19990045788** Royal Aeronautical Society, London, UK

### **Rotorcraft Flight Safety: Proceedings**

1998; In English; Rotorcraft Flight Safety, 3 Nov. 1998, London, UK; See also 19990045789 through 19990045795; ISBN 1-85768-079-0; Copyright; Avail: Issuing Activity (The Royal Aeronautical Society, 4 Hamilton Place, London, W1V 0BQ, UK), Hardcopy, Microfiche

The underlying theme of today's conference is what we can do to improve Rotorcraft flight safety in the future. It is interesting to note that, on the operational side, we have speakers on Public Transport operations in the very hostile areas of the emergency services sector and the military. On the airworthiness side we'll learn of the regulation and management of airworthiness and of safety assessments. The increasingly important topic of Human factors will be covered by my colleagues from the Safety Regulation Group (SRG), and, finally, two other eminent speakers in the fields of rotorcraft handling qualities and human engineering will conclude.

Derived from text

*Aircraft Reliability; Conferences; Flight Safety; Human Factors Engineering; Rotary Wing Aircraft; Helicopter Performance*

**19990045789** Shell Aircraft Ltd., London, UK

### **A Customer Perspective on Helicopter Safety in North Sea Operations**

Clark, Eric, Shell Aircraft Ltd., UK; 1998; In English; See also 19990045788

Report No.(s): Paper-1; Copyright; Avail: Issuing Activity (The Royal Aeronautical Society, 4 Hamilton Place, London, W1V 0BQ, UK), Hardcopy, Microfiche

The UK CAA records a steady improvement over the past ten years in the overall accident rate for helicopters in offshore operations, although this has levelled off in the past 2 years, and may have achieved the plateau in safety which is currently worrying the airline industry. One of our concerns as a customer is that the helicopter industry is not necessarily learning from the airlines at a time when the baseline accident rate for the airline industry is generally at least an order better than that of helicopters. The paper highlights the need to set safety, both strategic and localized, and to focus efforts on developing a coherent program to meet these targets. This requires a deeper understanding of causal factors of accidents and, in particular, how human error contributes; it also requires the use of techniques, such as flight data analysis, from other parts of the industry and a willingness to share knowledge to a greater than at present. However, any breakthrough in safety performance must be sustained by a systematic approach to the management of safety, supported by a hazard analysis and risk assessment appropriate to each operation. This should eventually become part of the culture to achieve continuous improvement in safety performance.

Author

*Flight Training; Helicopters; North Sea; Civil Aviation; Flight Safety; Aircraft Safety; Aircraft Hazards; Risk; Aircraft Reliability*



**19990045790** Ministry of Defence, Airworthiness Design Requirements and Procedures, Bristol, UK

**The Regulation and Management of Airworthiness by MoD**

Dallimore, Colin, Ministry of Defence, UK; Rotorcraft Flight Safety: Proceedings; 1998; In English; See also 19990045788  
Report No.(s): Paper-4; Copyright; Avail: Issuing Activity (The Royal Aeronautical Society, 4 Hamilton Place, London, W1V 0BQ, UK), Hardcopy, Microfiche

This paper reviews the means by which the airworthiness of military aircraft is regulated and managed by the UK Ministry of Defense (MOD). Following a summary of the legal environment within which MOD operates the MOD airworthiness organization is introduced along with the basic principles used to establish and maintain the required standard of air worthiness. The process by which safety management initiatives are taken forward is addressed and future development identified.

Author

*Aircraft Reliability; Safety Management; Military Aircraft; Aircraft Survivability*

**19990045791** Westland Helicopters Ltd., System Safety Engineering, Yeovil, UK

**A Contractor Perspective on Helicopter Airworthiness and Safety Analysis Developments**

Allen, Roger J., Westland Helicopters Ltd., UK; 1998; In English; See also 19990045788  
Report No.(s): Paper-5; Copyright; Avail: Issuing Activity (The Royal Aeronautical Society, 4 Hamilton Place, London, W1V 0BQ, UK), Hardcopy, Microfiche

Today's approach to aircraft safety within GKN Westland Helicopters (GKN WHL) reflects the rigorous demands made by today's operator and society in general. The paper begins by suggesting that the number of rotorcraft accidents should not increase in similar manner to that pessimistically predicted for airliners. The background to GKN WHL's airworthiness effort is described by taking the wider view of the design process and contributory disciplines. The paper goes on to describe some of the initiatives which will help to shape the operational side of aircraft safety. GKN WHL's experience with formal safety analysis is discussed, noting the use of a new concept to assess the aircraft as a complete entity. The benefits of safety analysis and some further observations based on experience are included. Finally the paper looks ahead to what the future holds with regard to helicopter safety initiatives.

Author

*Aircraft Reliability; Aircraft Safety; Helicopters; Safety Management; Structural Reliability; Helicopter Performance; Quality Control*

**19990045794** Defence Evaluation Research Agency, Flight Management and Control Dept., Bedford, UK

**Controlling Tension Between Performance and Safety in Helicopter Operations: The Contribution of Handling Qualities to Flight Safety**

Padfield, Gareth D., Defence Evaluation Research Agency, UK; Rotorcraft Flight Safety: Proceedings; 1998; In English; Rotorcraft, Sep. 1998, Marseilles, France; See also 19990045788  
Report No.(s): Paper-8; Copyright; Avail: Issuing Activity (The Royal Aeronautical Society, 4 Hamilton Place, London, W1V 0BQ, UK), Hardcopy, Microfiche

As twin goals in the design and operation of aircraft, performance and safety often struggle together for prominence. This struggle creates a tension that runs throughout the design, development and qualification process. The tension is felt most when missions are stressed, in the sense of being at the extremes of the requirements; for example, operations into degraded visual conditions in poor weather or when the degree of urgency increases, in emergency maneuvers or when the pilot is required to divide attention between flying and other mission duties. Two important contributions assist the pilot in managing this tension. First, designs which confer the aircraft with sufficiently good handling characteristics, such that even in emergency conditions, the attentional demands of control workload are acceptable. Second, providing sufficient spatial awareness relative to the surrounding airspace and surface/obstacle layout that the pilot is able to maintain an adequate safety margin. In this paper, mission oriented flying qualities engineering is described within the system framework of Aeronautical Design Standard-33 (ADS-33), utilizing concepts like the mission task element, usable cue environment, and dynamic response criteria. The paper argues that the requirements for what constitutes safe and easy, Level 1 flying qualities now exist and are well substantiated. New flying qualities now exist and safety standards, and existing aircraft can be upgrade with integrated flight management systems featuring advanced control/flying management technologies. Good flying qualities provide critical support to the pilot in the management of the performance-safety tension. This paper will examine this tension in more detail, drawing on results of probabilistic analysis of the impact of flying qualities on flight safety.

Author

*Aircraft Performance; Flight Management Systems; Flight Safety; Helicopters; Safety; Pilot Performance*

**19990045795** Defence Evaluation Research Agency, Systems Integration Dept., Farnborough, UK

**Safety Related Technology at the Man/Machine Interface**

Rood, G. M., Defence Evaluation Research Agency, UK; 1998; In English; See also 19990045788

Report No.(s): Paper-9; Copyright; Avail: Issuing Activity (The Royal Aeronautical Society, 4 Hamilton Place, London, W1V 0BQ, UK), Hardcopy, Microfiche

As with their fixed wing counterparts, the technology of avionic and other systems in helicopters is increasing in complexity, and this increase generally results in the aircraft being provided with increasing amounts of data - not necessarily in the right information format for easy digestion. The pilot is often flying in poor weather that may be marginal for the aircraft safety limits and has to take this data, process it to get a form that is relevant and interact with the displays which s/he will need to ensure the correct inputs are entered at the right time and quickly enough, to get the operationally relevant information out. It is most unlikely, that the helicopter avionics, navigation or other systems will become less complex and with this increasing complexity and number of systems generally comes the need to process more outputs and ensure that the entry of a greater number of inputs is both timely and correct, and the additional time required to carry out these tasks is not always available. This is so certainly for military helicopters, and will be increasingly so for civil systems as the military technologies and systems are transferred to the civil market.

Author

*Aircraft Safety; Avionics; Display Devices; Man Machine Systems; Helicopter Control; Helicopter Design; Helicopters; Helicopter Performance*

**19990045796** Nebraska Univ., Aviation Inst., Omaha, NE USA

**The Conference Proceedings of the 1998 Air Transport Research Group (ATRG) of the WCTR Society, Volume 1**

Oum, Tae Hoon, Editor, British Columbia Univ., Canada; Bowen, Brent D., Editor, Nebraska Univ., USA; The Conference Proceedings of the 1998 Air Transport Research Group (ATRG) of the WCTR Society; December 1998; 352p; In English; Triennial World Conference on Transportation Research, 12-17 Jul. 1998, Antwerp, Belgium; Sponsored by World Conference on Transportation Research Society; See also 19990045797 through 19990045815; Sponsored in part by the NASA Nebraska Space Grant Consortium and the NASA National Space Grant College and Fellowship Program

Contract(s)/Grant(s): NAGw-4414

Report No.(s): UNOAI-98-6; Copyright Waived; Avail: CASI; A16, Hardcopy; A03, Microfiche

This report (Volume 1) is comprised of 5 sessions of the Air Transport Research Group (ATRG) Conference held in Antwerp, Belgium, July 1998. The sessions contain 3-4 papers (presentations) each. The session numbers and their respective headings are: (1) Airline alliances; (2) Airline Competition and Market Structure; (4) Liberalization, Open Skies, and Policy Issues; (5) Yield Management and Other Models; and (11) Air Traffic Control (ATC) and Air Navigational Systems (ANS).

Author

*Conferences; Air Transportation; Airline Operations; Air Traffic; Aeronautics; Aircraft Safety*

**19990045797** City Univ. of Hong Kong, Dept. of Economics and Finance, Kowloon, Hong Kong

**Strategic Airline Alliances: Complementary Versus Parallel Alliances**

Park, Jong-Hun, City Univ. of Hong Kong, Hong Kong; Zhang, Anming, City Univ. of Hong Kong, Hong Kong; The Conference Proceedings of the 1998 Air Transport Research Group (ATRG) of the WCTR Society; December 1998; Volume 1; 33p; In English; See also 19990045796; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

Strategic alliances have occurred in a broad spectrum of industries including the airline industry. This paper presents a model that examines the effects on market outcome and welfare of two types of strategic alliances: complementary vs parallel alliances. It is identified that the two alliances have different effects on total output and consumer surplus. The complementary alliance is likely to increase total output, while the parallel alliance is likely to decrease it. We find sufficient conditions under which each type of alliance improves total welfare. The empirical test results from the trans-Atlantic alliance routes for the 1990-1994 period, confirm the theoretical predictions on partners' outputs and total output.

Author

*Airline Operations; Routes; Cost Reduction; Air Transportation; Mathematical Models; Market Research*

**19990045798** Sydney Univ., Inst. of Transport Studies, Australia

**Strategic Alliances Among International Airlines and Their Implications for Organisational Changes**

Brewer, Ann, Sydney Univ., Australia; Hooper, Paul, Sydney Univ., Australia; The Conference Proceedings of the 1998 Air Transport Research Group (ATRG) of the WCTR Society; December 1998; Volume 1; 13p; In English; See also 19990045796; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

Globalization has resulted in international trade progressing beyond the stage where national firms specialize in finished products. Specialization now occurs in the production of components and the modern trading enterprise engages in global sourcing. Improvements in communications and transport have made this possible, but competition, rising customer expectations and the need to expand markets beyond national boundaries leave many businesses with no alternatives but to "go global". Against this background, researchers have paid increasing attention to the attempts in the airline industry to globalize. While it is true that the larger international carriers compete simultaneously in several inter-continental markets, restriction on foreign investment and commercial operating rights generally deny airlines the opportunity to become global businesses in their own rights. Airlines do not have free access to markets, nor do they have the freedom to invest and operate wherever they want. The principles of comparative advantage do not prevail in the trade in airline services and consequently, airlines are prevented from developing efficient global networks. Alliances allow airlines to circumvent restrictions on market access while simultaneously permitting them to co-ordinate schedules, and to pursue other practices designed to reduce cost and improve customer service. The strategic alliance has become the key instrument for global expansion.

Derived from text

*Airline Operations; Competition; Cost Reduction; Economics; Market Research*

**19990045799** George Mason Univ., Inst. of Public Policy, Fairfax, VA USA

**Aviation Safety and the Increase in Inter-Airline Operating Agreements**

Button, Kenneth, George Mason Univ., USA; The Conference Proceedings of the 1998 Air Transport Research Group (ATRG) of the WCTR Society; December 1998; Volume 1; 20p; In English; See also 19990045796; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

Aviation is becoming increasingly internationalized not only because international traffic is itself growing rapidly but also because airlines are themselves beginning to lose their national identity as cross-equity holdings expand and as airline alliances grow in number. These changes affect the commercial and the regulatory environment in which aviation services are provided but they also have potential implications for air transport safety. Although air transport safety is often treated as a part of public policy it is also influenced by the commercial interests of the airlines themselves. While there has been a recognition of the need for a public policy response to the new world of globalization and strategic alliances that are now part of the air transport market, this policy response needs to be made in the context of changing private incentives affecting airlines own attitudes to safety. This paper focuses on the changes in private incentives that the growth in airline alliances in particular may have on safety.

Author

*Air Transportation; Aircraft Safety; Airline Operations; Commercial Aircraft; Flight Safety; Policies*

**19990045800** Alberta Univ., Dept. of Economics, Edmonton, Alberta Canada

**Schedule Competition, Fare Competition and Predation in a Duopoly Airline Market**

Lindsey, Robin, Alberta Univ., Canada; Tomaszewska, Ewa, Alberta Univ., Canada; The Conference Proceedings of the 1998 Air Transport Research Group (ATRG) of the WCTR Society; December 1998; Volume 1; 18p; In English; See also 19990045796 Report No.(s): Paper-92-Rev; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

Since deregulation of the U.S. airline market, airline competition has been the subject of intensive research. Interest has been sustained by the ongoing evolution of the U.S. market, deregulation in Canada, and the evolutionary process of deregulation underway in Europe. Competition between airlines occurs in various dimensions, including fares, capacity, flight schedules, frequent flier programs, computer reservations systems, code-sharing agreements and alliances. This paper focuses on competition in fares and flight schedules. Fare competition has been the subject of many studies in the literature. The importance of schedule frequency has also been recognized. The timing of flights is clearly another important factor determining the attractiveness of an airline because of traveler's preferences for when they depart and/or arrive. Another focus of this paper is predation in airline markets.

Derived from text

*Airline Operations; Competition; Schedules; Cost Reduction; Operating Costs; Operational Problems; Market Research*

**19990045801** Maison Rhone-Alpes des Sciences de l'Homme, Lab. d'Economie des Transports, Lyon, France

**A Model of Air Transport Duopoly in Price and Service Quality**

Molin, Benedicte, Maison Rhone-Alpes des Sciences de l'Homme, France; The Conference Proceedings of the 1998 Air Transport Research Group (ATRG) of the WCTR Society; December 1998; Volume 1; 12p; In English; See also 19990045796; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

The liberalization process of the air transport industry in Europe, which officially ended in April 1977, echoes the American Air Deregulation Act (ADA) that was passed some twenty years earlier, in 1978. Quite logically the european observers try to



infer from the American experience what the evolution of the industry can be on their own continent. In particular, one of the most spectacular consequences, of the ADA was the continent-wide development of hub-and-spoke systems, in which all passengers, whatever their origins and destinations are channeled to a hub airport, where they find convenient intraline connections to reach their final destination. Such networks were initially developed by the major air carriers to minimize their operating costs (owing to the flow consolidation on the spokes); hubbing also gave them the opportunity to monopolize the hub airport's resources by the concentration of incoming and outgoing flights on a short time span and is therefore an interesting tool to lower the contestability of the hub markets. Although the American experience has been extensively analyzed, very little can be learned to forecast the future of the European flag carriers' networks. In this purpose a two stage duopoly model is proposed in this paper, which considers both prices and network patterns as endogenous variables. This model structure is suggested by the American experience - that made it clear that a carrier's network can act as a strategic tool just like other more classic devices, such as marketing or prices - and by the industry practices themselves: the two-period structure is meant to more or less reproduce the fact that at every season for the next one the carriers choose the slots they will need at the airports they want to serve, publish their timetables, while their prices generally keep on varying until the last ticket is sold. The paper is organized as follows : section I presents the model, which is then solved in section II; the empirical test of the model is conducted in section III on American data.

Author

*Air Transportation; Europe; Airline Operations; Mathematical Models; Market Research; Operating Costs; Networks; Services*

**19990045802** Vrije Univ., Tinbergen Inst., Amsterdam, Netherlands

### **Frequency Equilibria and External Costs in Duopoly Airline Markets**

Schipper, Youdi, Vrije Univ., Netherlands; Nijkamp, Peter, Vrije Univ., Netherlands; Rietveld, Piet, Vrije Univ., Netherlands; The Conference Proceedings of the 1998 Air Transport Research Group (ATRG) of the WCTR Society; December 1998; Volume 1; 22p; In English; See also 19990045796; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

As a result of the strong growth of air transport over the past decades, the external costs of aviation have become an important concern in public policy. In order to analyze the problem of externalities and formulate policy responses, one needs to know how decisions made in airline markets affect other sectors of the economy. It can be argued that in many transport markets, frequency of service is one of the main factors determining the external cost total in a market. In airline markets, for example, the size of externalities as noise and emission of pollutants depends largely on the number of landings and take-offs. On the other hand, frequency of service is also a measure of quality in transport and as such affects consumer welfare. In order to analyze these conflicting effects on welfare, the paper models frequency equilibria in duopoly air transport markets.

Derived from text

*Market Research; Air Transportation; Airline Operations; Costs; Mathematical Models; Computerized Simulation; Demand (Economics)*

**19990045803** Monash Univ., Dept. of Economics, Clayton, Australia

### **The Use of Market Power in International Aviation and Tourism**

Forsyth, Peter J., Monash Univ., Australia; The Conference Proceedings of the 1998 Air Transport Research Group (ATRG) of the WCTR Society; December 1998; Volume 1; 22p; In English; See also 19990045796  
Report No.(s): Paper-1225; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

In order to make international trips, visitors must use some form of transport, such as aviation. Countries possess a degree of market power over tourism within their borders, and they often seek to use this. This market power also transfers over to aviation; they control air routes jointly with their trading partners, and they often restrict supply, sometimes with the intention of generating profits. However, they must share traffic and profits with their partners. Governments also levy taxes on tourism, but these affect domestic tourists and residents. A model is developed which combines all these features. It is possible to use it to characterize the best possible combination of aviation and tourism policies from the perspective of an individual country. A country typically does not have full control over aviation policies, and this can be allowed for. What is desirable from the perspective of an individual country is not desirable from a world perspective. In tourism, and to a lesser extent, countries are able to levy optimum tariffs, which benefit themselves but lessen overall world welfare. There is evidence that countries are becoming more aware of their market power as international aviation becomes increasingly liberalized, countries are imposing more taxes on tourism.

Author

*Governments; Policies; Airline Operations; Air Transportation; Tourism; Mathematical Models; Operations Research*

**19990045804** Texas A&M Univ., Dept. of Management, College Station, TX USA

**A Preliminary Assessment of the 1995 Canada-US Transborder Air Services Agreement**

Pustay, Michael W., Texas A&M Univ., USA; The Conference Proceedings of the 1998 Air Transport Research Group (ATRG) of the WCTR Society; December 1998; Volume 1; 14p; In English; See also 19990045796; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

While trade in most goods and services between the USA and Canada is generally open, such was not the case for transborder airline services for most of the post-war period. Indeed, for almost three decades the accord governing Canada-U.S. airline service was among the most restrictive of all such pacts entered into by the USA. At the 1985 Shamrock Summit, Prime Minister Mulroney and President Reagan recognized the inappropriateness of that state of affairs and that promotion of transborder air travel should be encouraged. Yet it took the two nations a decade to remedy the problem; only in February 1995 did they sign a new air services agreement (ASA) that significantly liberalized trade in airline services between them. The purpose of this paper is to explore the impact of the February 1995 ASA on the market for transborder airline services. The issue is of particular importance because past regulatory policies have affected the ability of individual carriers to benefit from the new ASA. As a result, the likelihood that competition in certain markets could be hindered is a real concern. To assess these effects, the paper begins by reviewing the domestic, international and transborder aviation policies of the two countries. After discussing the provisions of the new ASA, it then examines its impact on competition and concentration in the transborder air services market.

Derived from text

*Air Transportation; Airline Operations; Policies; International Relations*

**19990045805** British Columbia Univ., Faculty of Commerce and Business Administration, Vancouver, British Columbia Canada

**An Analysis of Profitability of the World's Major Airlines**

Oum, Tae Hoon, British Columbia Univ., Canada; Yu, Chun-Yan, British Columbia Univ., Canada; The Conference Proceedings of the 1998 Air Transport Research Group (ATRG) of the WCTR Society; December 1998; Volume 1; 20p; In English; See also 19990045796; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

Airline profitability depends on airlines' cost competitiveness and their ability to price above costs, the ability to set prices above cost depends on market power and the firm's ability to make use of innovative pricing techniques and market information. In the past, some carriers have been profitable without being cost competitive because they were able to charge exorbitant prices to consumers. Increased competition in the international air transport markets have put pressures on carrier's ability to raise prices. At the same time, input prices have been increasing continuously. To counter-act such trends, airlines have made tremendous efforts to improve efficiency and productivity in order to cut costs. Using a yearly panel of 22 major airlines over the 1986-95 period, this paper examines airlines' profitability changes by examining changes in productivity and their ability to price above cost. The study found that European and Asian carriers consistently improved productivity throughout the period even during the time of rising profitability, achieving higher productivity growth than North American carriers. However, European and Asian carriers experienced much faster decline under the pressures of increased competition. Overall, airline profitability have improved during the 1990s.

Author

*Air Transportation; Airline Operations; Competition; Mathematical Models*

**19990045806** University of Southern Illinois, Carbondale, IL USA

**Airlines, Governments and the Distribution of Air Travel Services in a Changing Global Economy**

Tarry, Scott E., University of Southern Illinois, USA; The Conference Proceedings of the 1998 Air Transport Research Group (ATRG) of the WCTR Society; December 1998; Volume 1; 22p; In English; See also 19990045796; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

This paper is distilled from a more comprehensive project on the implications of globalization and liberalization in air transport. It is organized to give the reader with some background in the political economy of the air transport industry, but perhaps a limited knowledge of the concept of globalization, a sufficient foundation of knowledge to make sense of the analysis and arguments about the current trends and probable future of the industry. Thus, after an initial discussion of the concept of globalization, the second section of the paper briefly outlines the history of the international air transport industry. The third section discusses the American roots of current international liberalization efforts and the particular role that American airlines play in the political and economic transformation of this industry. This discussion is followed by an update of the industry, which is changing quickly, and, in some cases, quite dramatically. The final two sections offer some analysis and conclusions about the ramifications of the current trends in liberalization of the air transport industry with special attention on the impact of these trends on policy making and economic growth and development in both the industrialized and developing worlds. Two cases, one focusing narrowly on

St. Louis, an American city and the other focusing broadly on Africa, help bring the theoretical and abstract discussion into the real world of policy making and commerce.

Derived from text

*Air Transportation; Airline Operations; Civil Aviation; Economics; Governments; Policies; International Cooperation*

**19990045807** Kobe Univ., Dept. of Civil Engineering, Japan

**Domestic Aviation Network Analysis and Aviation Policy Scenario**

Kuroda, Katsuhiko, Kobe Univ., Japan; Takebayashi, Mikio, Kobe Univ., Japan; Hirai, Kazuto, Kobe Univ., Japan; The Conference Proceedings of the 1998 Air Transport Research Group (ATRG) of the WCTR Society; December 1998; Volume 1; 16p; In English; See also 19990045796; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

The recent tendency of globalization and /or internationalization stimulates the air-demand more and more. In Japan, 66.9 million passengers used domestic flights in 1995. About 56.4 million passengers, 81% of domestic air passengers, used either Tokyo International Airport (henceforth called as TKY) or Osaka International Airport (henceforth called as OSA) or both. Only 19% of domestic air passengers used other local flights. The flight number of both airports reaches the limit of their capacity, and that of Kansai International Airport (henceforth called as KIX) opened in 1994, is also estimated to be saturated in the near future. Thus, New Chubu International Airport is being planned. Under these situations, it is necessary to develop suitable and easy tools to analyze the impact on the air passengers' flow by the construction of the new airport. There has been much research in the field of demand forecast under a given aviation network. Research by Morichi et al (1993), and Furuichi et al (1993) are examples of introducing the logic type models. However, these do not consider the strategic behavior of airlines. Todoroki et al (1992), Kita et al (1995) and Takase et al (1995) developed models to consider the behavior of airlines and passengers. These are quite interesting in the sense that they include the objective functions of both of airlines and passengers. However, they lack the approach to an "equilibria" between airlines and passengers. Ohashi et al (1996) formulated the equilibrium between airlines and passengers as the "general equilibrium" considering the aviation fee and flight frequency. The model is very precise from the theoretical viewpoint. However, when that model is applied to the real aviation network, it may be difficult to take the equilibrium solution because it requires the a large amount of computation. Taking these into account, the present paper aims to develop an easier analytical tool to obtain the equilibrium flow in the air transportation network. In the real air transportation market, (1) the flow of passengers and/or goods is the resultant equilibrium in the market through strategic behaviors of transportation agencies (henceforth called carrier) and passengers or shippers (henceforth called user) under the governmental policies which include airport construction and its management, (2) the carrier has the perfect information about the users' behavior, but users have the limited information provided by the carrier, (3) the relationship between the carriers and users is not interactive. This situation of air transportation market constituted of the government, the carrier, and the user can be regarded as the game referred to as the Stackelberg Problem. Under these conditions, Kuroda and Takebayashi (1996, 1997) developed a model to obtain the Stackelberg equilibria among carriers (airlines and railways) and passengers under given inter-regional O.D. distribution of demand. The present paper analyzes the impact of the construction of New Chubu International Airport on the air passengers' flow based on their model.

GISS

*Network Analysis; Air Transportation; Airline Operations; Civil Aviation; Transportation Networks; Mathematical Models*

**19990045808** Boeing Commercial Airplane Co., Seattle, WA USA

**Spill Modeling for Airlines**

Swan, William M., Boeing Commercial Airplane Co., USA; The Conference Proceedings of the 1998 Air Transport Research Group (ATRG) of the WCTR Society; December 1998; Volume 1; 16p; In English; See also 19990045796; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

Spill models estimate average passenger loads when demand occasionally exceeds capacity. Such models have been in use for over 20 years. The shape of the distribution of demand is discussed from both theory and observation. Sources of variance are identified and calibrated. Measurement problems and techniques are discussed. Two alternate spill formulas are presented based on normal distributions of demand. A revision is presented which responds to changes in process caused by computer reservation system and revenue management. The concept that the spill losses should be valued at discount fares is discussed. The recapture of spilled demand is presented as well as when such a phenomenon is relevant. Comparison of various sources of error is included. Finally, the use of spill models in reverse to imply demand from load is shown to have poor accuracy. The paper is meant to offer to the literature a reference for basic use. It is the result of 15 years' involvement in spill model derivation, calibrations and applications.

Author

*Airline Operations; Air Transportation; Mathematical Models; Demand (Economics); Distribution Functions*

**19990045809** Nanyang Technological Inst., Nanyang Business School, Singapore

**Airline Spill Analysis: Beyond the Normal Demand**

Li, Michael Z. F., Nanyang Technological Inst., Singapore; Oum, Tae Hoon, British Columbia Univ., Canada; The Conference Proceedings of the 1998 Air Transport Research Group (ATRG) of the WCTR Society; December 1998; Volume 1; 18p; In English; See also 19990045796; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

Most research on airline passenger spill has assumed the normal distribution of the nominal demand. But, there are plenty of empirical observations showing that the normal distribution does not fit very well in many occasions. This is true especially for the demand for business and first class compartments. In this paper, we derive formulae for calculating the expected number of spilled passengers for a group of flights for the cases where the nominal demand is assume to follow a normal, a logistic, a lognormal and a gamma distribution. The spills under the alternative distributional assumptions are compared numerically. Finally, the paper demonstrates that for each of the four distributions, one can construct a generic observed load factor table, which does not depend on aircraft seating capacity.

Author

*Airline Operations; Distribution Functions; Mathematical Models; Demand (Economics); Statistical Distributions*

**19990045810** National Cheng Kung Univ., Dept. of Transportation and Communication Management, Tainan, Taiwan, Province of China

**An Airline Dynamic Multiple-Fare Overbooking Strategy Model**

Chang, Yu-Hern, National Cheng Kung Univ., Taiwan, Province of China; Cheng, Jao-Hong, I-Shou Univ., Taiwan, Province of China; The Conference Proceedings of the 1998 Air Transport Research Group (ATRG) of the WCTR Society; December 1998; Volume 1; 12p; In English; See also 19990045796; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

It is standard practice for airline companies to allow passengers to cancel reservations booked in advance without penalty. In these circumstances, the likelihood is high that even with a given flight booked solid, seats would remain empty at take-off because of cancellation or passenger no-shows. In order to reduce the number of empty seats, airline companies resort to overbooking. Through carefully controlled overbooking, the airline companies can reduce the number of empty seats and at the same time serve the public interest by accommodating more passengers. A number of conventional airline overbooking models have been developed in the past several decades. Various techniques have been attempted, yielding different degrees of success in their experiments. These include recognition approaches, such as a single overbooking level of single fare model, a comprehensive non-nested seat allocation and overbooking model, and a comprehensive nested seat allocation and overbooking model. The model this paper describes is a more comprehensive and exact treatment of the airline reservation process than any of the foregoing.

Derived from text

*Cancellation; Passengers; Mathematical Models; Airline Operations*

**19990045811** Columbia Energy Group, Gas Management Services, Columbus, OH USA

**Assigning Arriving and Departing Transporters at Transfer Facilities**

Allman, William P., Columbia Energy Group, USA; Mount-Campbell, Clark A., Ohio State Univ., USA; The Conference Proceedings of the 1998 Air Transport Research Group (ATRG) of the WCTR Society; December 1998; Volume 1; 12p; In English; See also 19990045796; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

There are many facility operational planning scheduling situations for which, within a given time window, arriving and/or departing transporters carrying units originating at the facility, terminating at the facility, continuing through on the same transporter, or transferring to another transporter over some intra-facility transfer route, must be assigned physical locations within the facility. The assignment of transporters to locations must consider the feasibility of each transporter being serviced at the alternative locations. This paper deals with the assignment of transporters to locations according to a quantitative criterion. Suggested criteria consider measures for the transfer of originating units from the facility entrance(s) to their departing locations, plus the transfer of all terminating units from their arriving locations to the facility exit(s), plus the transfer of all transferring units over intra-facility location-to-location transfer routes. Such measures can be time, distance, or some combination thereof.

Derived from text

*Operational Problems; Scheduling; Airline Operations; Air Transportation; Mathematical Models; Airfield Surface Movements*

**19990045813** Technical Univ. of Warsaw, Faculty of Transport, Warsaw, Poland

**The Optimization Problem Formulation and Algorithm of Eliminating Flight Collisions**

Ambroziak, T., Technical Univ. of Warsaw, Poland; Drabik, D., Technical Univ. of Warsaw, Poland; The Conference Proceedings of the 1998 Air Transport Research Group (ATRG) of the WCTR Society; December 1998; Volume 1; 14p; In English; See also 19990045796; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche



The formulation of the optimization and an algorithm for eliminating flight collisions is presented in this paper. The optimization problem is addressed first: input data is described, the decision variables, and the restrictions are reviewed. The method of solving the optimization problem is also reviewed. The criterion of the optimization problem is that the total cost of all aircraft flights taking place in a given area be minimized, only after insuring flight schedules are free from collisions. The method of solving the optimization problem is to construct a flight graph. The implementation of the algorithm ensuring flights free from collisions is described. A block diagram of the process is presented, and the input data form is described. A computational example is described, which illustrates the process, which is used to illustrate the workings of the process, and illustrate a coordinated flight plan.

CASI

*Algorithms; Costs; Flight Plans; Schedules; Air Traffic Control; Optimization; Collision Avoidance; Flight Paths*

**19990046009** Federal Aviation Administration, Washington, DC USA

**Notices to Airmen, Domestic/International, March 25, 1999**

Mar. 25, 1999; 252p; In English

Report No.(s): PB99-139578; No Copyright; Avail: CASI; A12, Hardcopy; A03, Microfiche

Contents include the following: Airway Notams; Airports, Facilities, and Procedural Notams; General FDC Notams; Part 95 Revisions to Minimum En Route IFR Altitudes and Changeover Points; International Notices to Airman; Graphic Notices. NTIS

*Air Navigation; Runways; Airports; Graphs (Charts)*

**19990046013** Massachusetts Univ., Applied Science and Technology, Amherst, MA USA

**Anaerobic Treatment of Aircraft Deicing Wastes: A Technology Assessment Final Report**

Sep. 1998; 224p; In English

Report No.(s): PB99-137846; No Copyright; Avail: CASI; A10, Hardcopy; A03, Microfiche

The work contained in the study documents the fact that deicing wastes containing ethylene glycol (EG) and propylene glycol (PG) may be effectively treated using an anaerobic biological process. In the report, the treatment of aircraft deicing wastes under anaerobic methanogenic conditions is examined in detail. The major project tasks were: airport sampling to define the characteristics of waste from deicing operations; testing of EG and PG degradation using laboratory-scale reactors and then by means of serum bottle tests; operation of an anaerobic fluidized bed reactor (AFBR); and analysis of the energy aspects of anaerobic processes with cost comparisons to traditional aerobic processes.

NTIS

*Technology Assessment; Anaerobes; Deicing; Waste Treatment; Antiicing Additives*

**19990046106** Irvin Aerospace, Inc., Santa Ana, CA USA

**Recent Advances in Spin/Stall Recovery Parachute System Technology**

Delurgio, Phillip R., Irvin Aerospace, Inc., USA; Taylor, Anthony P., Irvin Aerospace, Inc., USA; 1997 Report to the Aerospace Profession: Forty First Symposium Proceedings; Sep. 1997, pp. 267-283; In English; See also 19990046095; Copyright; Avail: Issuing Activity (Society of Experimental Test Pilots, Lancaster, CA), Hardcopy, Microfiche

This paper presents recent advances in Spin/Stall Recovery Parachute System (SSRPS) technology, as advanced by Irvin Aerospace, Inc. and its customers. Specific discussions focus on the value of providing the entire system, rather than piece parts and the development of SSRPS controls which are simple and intuitive, incorporation of built-in test, some simple rules for sizing SSRPS's for commercial aircraft, and the use of digital simulations for analysis of aircraft recovery.

Author

*Recovery Parachutes; Digital Simulation; Size Determination; Control Boards*

**19990046107** Lockheed Martin Astronautics, Huntsville, AL USA

**First Flight Preparation and Testing the F-22A Raptor**

Metz, Paul, Lockheed Martin Astronautics, USA; 1997 Report to the Aerospace Profession: Forty First Symposium Proceedings; Sep. 1997, pp. 284-290; In English; See also 19990046095; Copyright; Avail: Issuing Activity (Society of Experimental Test Pilots, Lancaster, CA), Hardcopy, Microfiche

A successful first flight of the F-22A, Raptor, was conducted on 7 September 1997. Initial handling qualities were rated as Level 1 for takeoff, formation and landing tasks. There was very high correlation between test data and engineering prediction for the air data system, engines, performance and stability and control. Simulation proved to be useful tool for refining control

laws and handling qualities as well as subsystem operation. The test program now moves into a four-year development effort centered at Edwards Air Force Base.

Derived from text

*Controllability; Flight Tests; Aircraft Stability; F-22 Aircraft; Flight Simulation*

**19990046109** Test Squadron (0416th), Edwards AFB, CA USA

**The Development of Nuisance Warning Criteria for Ground Collision Avoidance Systems: Preliminary Findings**

Prosser, K. E., Test Squadron (0416th), USA; Fergione, J. A., Lockheed Martin Tactical Aircraft Systems, USA; Skoog, M. A., Test Squadron (0416th), USA; 1997 Report to the Aerospace Profession: Forty First Symposium Proceedings; Sep. 1997, pp. 307-318; In English; See also 19990046095; Copyright; Avail: Issuing Activity (Society of Experimental Test Pilots, Lancaster, CA), Hardcopy, Microfiche

The USA Air Force (USAF) has been actively pursuing ground collision avoidance system (GCAS) technology for the past decade. Despite this effort, controlled flight into terrain (CFIT) remains the number one cause of aircraft losses in the USAF. Research suggests that the primary limitation of current GCAS technology is the excessive occurrence of nuisance warnings. Pilots quickly learn to "tune out" GCAS warnings or turn the systems off entirely to avoid these false warnings. Currently, no criteria exists to indicate the threshold between valid warnings and those that will be considered nuisances by the pilots. The purpose of this nuisance criteria study was to develop just such a criteria that GCAS designers can use to optimize their systems to avoid nuisance warnings.

Author

*Flight Control; Collision Avoidance; Research*

**19990046379** Army Research Inst. for the Behavioral and Social Sciences, Alexandria, VA USA

**Optimizing Simulator-Aircraft Mix for U.S. Army Initial Entry Rotary Wing Training Final Report, Mar. 1998 - Mar. 1999**

Stewart, John E., III; Dohme, John A.; Nullmeyer, Robert T.; Mar. 1999; 53p; In English

Report No.(s): AD-A361814; ARI-TR-1092; No Copyright; Avail: CASI; A04, Hardcopy; A01, Microfiche

Early fixed wing research demonstrated that potential cost and training benefits could be derived from simulation-augmented primary flight training. Unfortunately, more recent research in this area has been the exception, not the rule. This is especially true in the case of rotary wing (helicopter) aircrew training research. The present report reviewed the research literature on military aviation transfer of training (TOT) research, and examined the current U.S. Army Initial Entry Rotary Wing (IERW) Program of Instruction. An in-depth review was also conducted on the recent IERW simulation research performed by the Army Research Institute (ARI) Rotary Wing Aviation Research Unit (RWARU). Review of the IERW TOT research showed that a combination of synthetic flight simulation and criterion-based training had the potential for saving training time and costs in the aircraft. Adaptive training aids such as the ARI RWARU Intelligent Flight Trainer, also showed promise. A research program, focusing on revising the current IERW program to optimize the use of simulation, was proposed. This program would include (a) criterion-based instructional strategies, (b) low cost simulation, and (c) investigation of different combinations of simulator vs. aircraft training events, in order to determine the optimal simulator/aircraft training "mix".

DTIC

*Helicopters; Flight Simulation; Flight Training*

**19990046424** Air Force Inst. of Tech., School of Engineering, Wright-Patterson AFB, OH USA

**A Value Focused Approach to Determining the Top Ten Hazards in Army Aviation**

Sperling, Brian K.; Feb. 25, 1999; 209p; In English

Report No.(s): AD-A361821; AFIT/GOR/ENS/99M-16; No Copyright; Avail: CASI; A10, Hardcopy; A03, Microfiche

The USA Army Safety Center is challenged with identifying the top ten most severe hazards in Army Aviation. This research utilizes value-focused thinking and multiattribute preference theory concepts to produce a decision analysis model designed to aid decision-makers in their analysis process. The severity model is based on the Army's Risk Management doctrinal manual and has been tailored specifically for aviation related accidents and hazards. The model determines the severity and risk ranking for 65 categories of accidents and 24 existing hazards. A sensitivity analysis is conducted to examine the effects of variations in the weights of the top-level criteria for accident and hazard severity. Recommendations are presented for ways to use the information contained in this report to assist in developing risk reduction controls focused on force protection. The model provides the decision-makers with a decision analysis methodology that is consistent with Army doctrine and the values of the current chain of command at the Army Safety Center. Furthermore the model can be adjusted for different leadership levels or situations.

DTIC

*Hazards; Decision Theory; Safety*

**19990046579** Boeing Co., Saint Louis, MO USA

**4TH Generation Escape System Technologies Demonstration, Phase II Final Report, Jul. 1995 - Feb. 1998**

McDonald, A. Blair; Jul. 1998; 224p; In English

Contract(s)/Grant(s): F33615-92-C-2290; AF Proj. 2868

Report No.(s): AD-A361827; MDC-97-K-0154; AFRL-HE-WP-TR-1998-0130; No Copyright; Avail: CASI; A10, Hardcopy; A03, Microfiche

The Fourth Generation Escape System Technologies Demonstration Program was conducted to develop and demonstrate technologies that will enable the expansion of the escape envelope beyond that of current, third generation escape systems. The areas of the escape envelope in which expansion was demonstrated were escape under low-altitude, adverse-attitude conditions and escape at extremely high speed. The primary technologies that were developed for demonstration were: controllable propulsion, digital flight controls, and devices for crew member protection at high speed. The program was a two-phase program. In Phase I, two competing controllable propulsion subsystems were designed, developed, and demonstrated. A trade study was used to select the propulsion system, the digital flight control system, and the high-speed protection devices to demonstrate in Phase II. In Phase II, the new technology systems were integrated into an ejection seat test vehicle and a series of ten ejection tests were conducted at a high-speed test track. The tests successfully demonstrated safe escape at speeds up to 700 knots equivalent airspeed and at adverse conditions as severe as 20 degrees of yaw at 450 knots equivalent airspeed. The system also successfully demonstrated an upward-seeking trajectory resulting in a ground avoidance capability.

DTIC

*Escape Systems; Ejection Seats; Flight Control*

**19990046603** Nebraska Univ., Aviation Inst., Omaha, NE USA

**The UNO Aviation Monograph Series: The Airline Quality Rating 1997, 1997**

Bowen, Brent D., Nebraska Univ., USA; Headley, Dean E., Nebraska Univ., USA; 1997; 50p; In English

Report No.(s): UNOAI-97-9; Copyright Waived; Avail: CASI; A03, Hardcopy; A01, Microfiche

The Airline Quality Rating (AQR) was developed and first announced in early 1991 as an objective method of comparing airline performance on combined multiple factors important to consumers. Development history and calculation details for the AQR rating system are detailed in The Airline Quality Rating 1991 issued in April, 1991, by the National Institute for Aviation Research at Wichita State University. This current report, Airline Rating 1997, contains monthly Airline Quality Rating scores for 1996. Additional copies are available by contacting Wichita State University or the University of Nebraska at Omaha. The Airline Quality Rating (AQR) 1997 is a summary of a month-by-month quality ratings for the nine major domestic U.S. airlines operating during 1996. Using the Airline Quality Rating system and monthly performance data for each airline for the calendar year of 1996, individual and comparative ratings are reported. This research monograph contains a brief summary of the AQR methodology, detailed data and charts that track comparative quality for major domestic airlines across the 12 month period of 1996, and industry average results. Also comparative Airline Quality Rating data for 1991 through 1995 are included to provide a longer term view of quality in the industry.

Author

*Airline Operations; Quality; Ratings; Civil Aviation; Commercial Aircraft; Passenger Aircraft*

**19990046775** Research Triangle Inst., Hampton, VA USA

**An Assessment of Technical and Production Risks of Candidate Low-Cost Attitude/Heading Reference Systems(AHRS)**

Yuchnovicz, Daniel, Research Triangle Inst., USA; Burgess, Malcolm, Research Triangle Inst., USA; Hammers, William, Optimal Solutions, USA; February 1999; 66p; In English

Contract(s)/Grant(s): NCA1-130; RTOP 538-11-11-01

Report No.(s): NASA/CR-1999-209096; NAS 1.26:209096; No Copyright; Avail: CASI; A04, Hardcopy; A01, Microfiche

This report provides an assessment of technical and production risks of candidate low-cost attitude/heading reference systems (AHRS) for use in the Advanced General Aviation Transport Experiments (AGATE) airplanes. A low-cost AHRS is a key component of modern "glass cockpit" flight displays for General Aviation (GA) aircraft. The technical capabilities of several candidate low-cost AHRS were examined and described along with the technical issues involved with using all solid-state components for attitude measurement. An economic model was developed which describes the expected profit, rate of return, and volume requirements for the manufacture of low-cost AHRS for GA aircraft in the 2000 to 2020 time frame. The model is the result of interviews with GA airframe manufacturers, avionics manufacturers and historical analysis of avionics of similar complexity. The model

shows that a manufacturer will break even after three years of AHRS production, realizing an 18 percent rate of return (23 percent profit) on an investment of \$3.5M over the 20 year period. A start-up production estimate showed costs of \$6-12M for a new company to build and certify an AHRS from scratch, considered to be a high-risk proposition, versus \$0.25-0.75M for an experienced avionics manufacturer to manufacture a design under license, a low-risk proposition.

Author

*Attitude Control; Risk; General Aviation Aircraft; Attitude (Inclination); Avionics*

## 04

### AIRCRAFT COMMUNICATIONS AND NAVIGATION

*Includes digital and voice communication with aircraft; air navigation systems (satellite and ground based); and air traffic control.*

**19990044104** Air Force Inst. of Tech., School of Engineering, Wright-Patterson AFB, OH USA

#### **Integrated UPS/INS Precision Approach Landing with M3AE Interference Avoidance**

Chastain, Stephan H.; Mar. 1999; 148p; In English

Report No.(s): AD-A361703; AFIT/GE/ENG/99M-03; No Copyright; Avail: CASI; A07, Hardcopy; A02, Microfiche

Several past research efforts have developed methods to take advantage of Global Positioning System (GPS) positioning and apply it to a precision landing system (PLS). There have been proposals to phase out the current Instrument Landing System (ILS) in favor of a more cost-efficient and effective system. Accomplishments have been made in detailing a system implementing an INS aided with differential GPS, a GPS pseudolite, and a radar altimeter to handle the critical PLS requirements. This research applies the newly developed Modified Multiple Model Adaptive Estimation (M3AE) architecture in an attempt to enhance the performance of a PLS in an environment involving GPS interference. The M3AE uses Multiple Model Adaptive Estimation (MMAE) and Kalman filtering techniques to estimate the levels of interference and the navigation performance of the aircraft simultaneously. In addition, in the original development of M3AE, the truth and filter model used were of the same order. This research serves as a demonstration of M3AE applied to system where the truth model is of a higher order than the filter model.

DTIC

*Global Positioning System; Landing Aids; Precision*

**19990045723** Air Force Inst. of Tech., Wright-Patterson AFB, OH USA

#### **An Efficient GPS Position Determination Algorithm**

Colon, Carlos R.; Mar. 1999; 81p; In English

Report No.(s): AD-A361729; AFIT/GE/ENG/99M-33; No Copyright; Avail: CASI; A05, Hardcopy; A01, Microfiche

The use of detect, or closed-form solutions of the trilateration equations used to obtain the position fix in GPS receivers is investigated. The paper is concerned with the development of an efficient new position determination algorithm that uses the closed-form solution of the trilateration equations and works in the presence of pseudorange measurement noise and for an arbitrary number of satellites. In addition, an initial position guess is not required and good estimation performance is achieved even under high GDOP conditions. A two step GPS position determination algorithm which 1) entails the solution of a linear regression problem and, 2) an update of the solution based on one nonlinear measurement equation is developed. The closed-form solution of the linear regression in step 1 provides an estimate of the GPS solution, viz., user position and user clock bias, as well as the estimation error covariance. In the update step 2, only two to three iterations are required, as opposed to five iterations which are normally required in the standard iterative least square algorithm currently used in GPS. The two step algorithm also provides a data driven prediction of the pseudorange measurement noise strength and the estimation error covariance. The mathematical derivation of the novel and efficient solution algorithm for the GPS pseudorange equations using stochastic modeling is validated in a realistic simulation experiment based on 5000 Monte Carlo runs. The algorithm's performance is discussed and compared to the conventional iterative least squares algorithm currently used in GPS.

DTIC

*Global Positioning System; Algorithms; Covariance; Geometric Dilution of Precision*



**19990045724** Air Force Inst. of Tech., School of Engineering, Wright-Patterson AFB, OH USA

**Analysis of Radio Frequency Interference Effects on a Modern Coarse Acquisition Code Global Positioning System (GPS) Receiver. Volume 1**

Johnston, Kenneth D.; Mar. 1999; 131p; In English

Report No.(s): AD-A361736; AFIT/GSO/ENG/99M-02; No Copyright; Avail: CASI; A07, Hardcopy; A02, Microfiche

The purpose of this thesis was to investigate the performance of a twelve channel Standard Positioning Service (SPS) based (Global Positioning System (GPS) receiver using an eight state Kalman filter in a hostile radio frequency (RF) environment and to develop instructional tools for teaching RF interference on GPS receivers. The two types of jamming signals generated included Continuous Wave (CW) and Swept CW. Actual GPS and jamming signals were used in the research. The signals received from GPS satellites exhibit a Doppler shift which vary between approximately plus six Kilohertz. The Doppler shift frequency can be reasonably predicted for a given time of day, for a given satellite, and for a known receiver location using GPS satellite almanac or ephemeris data. Additionally, the Pseudorandom Noise (PRN) Coarse Acquisition (C/A) code for each satellite exhibits specific maximum amplitude spectral lines. by tailoring the jamming signals to match with the Doppler shifted satellite frequencies and offsetting the jamming to a maximum spectral line, it was shown that individual Navstar XR5-M receiver channels for specific satellites could be selectively jammed/spoofed. Swept CW jamming resulted in pulling the XRS-M receiver tracking channels off frequency by up to 20 Kilohertz but resulted in a maximum position error of only 220 meters. The CW jamming of at least one of the XR5-M receiver channels resulted in position errors in the receiver in excess of 12 kilometers.

DTIC

*Global Positioning System; Radio Receivers; Artificial Satellites; Line Spectra*

**19990045725** Air Force Inst. of Tech., Wright-Patterson AFB, OH USA

**Analysis of Radio Frequency Interference Effects on a Modern Coarse Acquisition Code Global Positioning System (GPS) Receiver. Volume 2**

Johnston, Kenneth D.; Mar. 1999; 284p; In English

Report No.(s): AD-A361737; AFIT/GSO/ENG/99M-02; No Copyright; Avail: CASI; A13, Hardcopy; A03, Microfiche

The purpose of this thesis was to investigate the performance of a commercial-off-the-shelf twelve channel Standard Positioning Service (SPS) based Global Positioning System (GPS) receiver using an eight state Kalman filter in a hostile radio frequency (RF) environment and to develop instructional tools for teaching RF interference on GPS receivers. The two types of jamming signals generated included Continuous Wave (CW) and Swept CW. Actual GPS and jamming signals were used in the research. The signals received from GPS satellites exhibit a Doppler shift which vary between approximately plus six Kilohertz. The Doppler shift frequency can be reasonably predicted for a given time of day, for a given satellite, and for a known receiver location using GPS satellite almanac or ephemeris data. Additionally, the Pseudorandom Noise (PRN) Coarse Acquisition (CIA) code for each satellite exhibits specific maximum amplitude spectral lines. by tailoring the jamming signals to match with the Doppler shifted satellite frequencies and offsetting the jamming to a maximum spectral line, it was shown that individual Navstar XR5-M receiver channels for specific satellites could be selectively jammed/spoofed. Swept CW jamming resulted in pulling the XR5-M receiver tracking channels off frequency by up to 20 Kilohertz but resulted in a maximum position error of only 220 meters. The CW jamming of at least one of the XR5-M receiver channels resulted in position errors in the receiver in excess of 12 kilometers.

DTIC

*Global Positioning System; Radio Receivers; Artificial Satellites; Jamming; Radio Frequency Interference*

**19990045726** Air Force Inst. of Tech., School of Engineering, Wright-Patterson AFB, OH USA

**GPS Signal Offset Detection and Noise Strength Estimation in a Parallel Kalman Filter Algorithm**

Vanek, Barry J.; Mar. 08, 1999; 99p; In English

Report No.(s): AD-A361773; AFIT/GE/ENG/99M-30; No Copyright; Avail: CASI; A05, Hardcopy; A02, Microfiche

Measurements from Global Positioning System (GPS) satellites are subject to corruption by signal interference and induced offsets. This thesis presents two independent algorithms to ensure the navigation system remains uncorrupted by these possible GPS failures. The first is a parameter estimation algorithm that estimates the measurement noise variance of each satellite. A redundant measurement differencing (RMD) technique provides direct observability of the differenced white measurement noise samples. The variance of the noise process is estimated and provided to the second algorithm, a parallel Kalman filter structure, which then adapts to changes in the real-world measurement noise strength. The parallel Kalman filter structure detects and isolates signal offsets in individual GPS satellites. The offset detection algorithm calculates test statistics on each of the filters and makes decisions on whether to remove satellites from the solution based on these statistics. The two algorithms contain several user-defined parameters that have

significant effects when adjusted. The various effects of parameter variation are described and a parameter set is chosen at which to evaluate the algorithms. The combined algorithm performs quite well in computer simulations.

DTIC

*Kalman Filters; Global Positioning System; Inertial Navigation*

**19990045732** Air Force Inst. of Tech., Wright-Patterson AFB, OH USA

**An Integrated Synthetic Aperture Radar/Global Positioning System/Inertial Navigation System for Target Geolocation Improvement**

Young, Brian J.; Mar. 1999; 172p; In English

Report No.(s): AD-A361800; AFIT/GE/ENG/99M-32; No Copyright; Avail: CASI; A08, Hardcopy; A02, Microfiche

This thesis explores a potential integration technique to fuse information from an inertial navigation system (INS) and global positioning system (GPS) with synthetic aperture radar target measurements. Using Kalman filtering techniques, an INSIGPS/SAR integrated system was simulated in a single Kalman filter to analyze the SAR target geolocation accuracy benefits. Three different GPS receiver models were used in the integrated system: stand-alone (SGPS), differential (DGPS), and carrier-phase differential GPS (CPGPS). Each of these GPS models were integrated with a common INSISAR combination to determine the target geolocation accuracy improvements due only to GPS receiver type. Thesis results show that SAR targeting can be enhanced, through tight integration of an INS/GPS navigation system, without increasing the SAR resolution. This work represents some of the first integrations work of only SAR range and range rate measurements into an INS/GPS integrated system to provide better accuracy in estimating ground target geolocation errors.

DTIC

*Synthetic Aperture Radar; Global Positioning System; Inertial Navigation*

**19990045812** Government of the Northwest Territories, Canada

**NAV CANADA's Provision of Air Navigational Services in Northern and Remote Areas**

Kaduck, Raymon J., Government of the Northwest Territories, Canada; The Conference Proceedings of the 1998 Air Transport Research Group (ATRG) of the WCTR Society; December 1998; Volume 1; 18p; In English; See also 19990045796; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

In 1996, Canada became the first nation to fully commercialize its air navigational system. Other jurisdictions had placed their ANS under a government controlled and owned entity, but the Canadian solution went further. The assets and personnel were transferred from Transport CANADA to a non-share corporation called NAV Canada, governed by a board of directors drawn from stakeholder groups. Transport Canada retained a purely regulatory role, ensuring that safety standards were maintained. In the process of negotiating the transfer, some argued that the nascent ANS corporation should only be responsible for the southern airspace, while TC should continue to manage the northern and remote areas, where low traffic densities and high operating costs make full cost recovery for the system not feasible. This view was rejected and the ANS transferred in its entirety. Northern stakeholder groups were alarmed that this might mean that full cost recovery should be implemented in their fragile economy. They lobbied for exemptions in the bill which would protect northern interest. This paper concerns the lobbying process, the safeguards in the ANS Act, and the early issues in implementing a commercialized ANS in the Northern and remote regions.

Derived from text

*Canada; Remote Regions; Air Navigation; Flight Management Systems; Air Traffic Control; Commercialization*

**19990045815** National Cheng Kung Univ., Dept. of Transportation and Management Science, Tainan, Taiwan, Province of China  
**Developing an On-Line Air Traffic Flow Management System**

Dai, Melody D. M., National Cheng Kung Univ., Taiwan, Province of China; The Conference Proceedings of the 1998 Air Transport Research Group (ATRG) of the WCTR Society; December 1998; Volume 1; 12p; In English; See also 19990045796  
Contract(s)/Grant(s): NSC-86-2621-E-006-020; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

Air traffic has increased significantly in Taiwan, especially domestic flights. Most of the domestic traffic is distributed in the west coast corridor, operating as city-pair shuttle services. The Sung Shan Airport, servicing Taipei, is the largest and busiest airport in Taiwan. The airport has only one runway, causing serious delays. During adverse meteorological conditions, the situation gets even worse. Thus traffic flow management is required. Due to limited airspace, ground holding is the most effective method of traffic flow management. The effectiveness of the ground holding policy depends on the timing. This involves the recognition

of congestion. This study develops a real time operating system to help the air traffic controllers determine when and how to implement the ground holding policy.

CASI

*Air Traffic Control; Management Systems; Real Time Operation; Flight Plans; Aircraft Guidance; Aircraft Approach Spacing; Approach Control*

**19990045846** European Organization for the Safety of Air Navigation, Bretigny-sur-Orge France

**SAPPHIRE: First Results**

Bondarenko, N.; Lipp, A.; Tiemeyer, B.; Watt, A.; Jun. 1998; 42p

Report No.(s): PB99-136202; EEC-330; Copyright; Avail: National Technical Information Service (NTIS), Microfiche

This report presents first results on the availability of Receiver Autonomous Integrity Monitoring (RAIM) onboard of commercial aircraft derived from the EUROCONTROL Flight Trial Programme SAPPHIRE (Satellite and Aircraft Database Programme for System Integrity Research). The objective of this program is to develop a statistically representative database of regular GNSS and other navigation sensor measurements to investigate system integrity, availability and continuity of service aspects in order to contribute of service aspects in order to contribute to the GNSS certification process. The data evaluation process is explained together with the set of navigation performance requirements which will be initially used before first results are presented and discussed.

NTIS

*Navigation Satellites; Data Recording; Global Positioning System; Data Bases; Navigation Instruments*

**19990045871** Civil Aeromedical Inst., Oklahoma City, OK USA

**Optimizing Blink Parameters for Highlighting an Air Traffic Control Situation Display Final Report**

Milburn, Nelda J.; Mertens, Henry W.; Mar. 1999; 26p; In English

Report No.(s): AD-A362158; DOT/FAA/AM-99/8; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

Research suggests blinking targets are more alerting than steady targets; however, several factors can interact with blinking to either improve or degrade its attention-getting value. Those factors include target size, color, brightness contrast, frequency of blink, and the time the blink is at maximum brightness relative to the time it is off or dim during the blink cycle. No guidelines were found for determining the optimal attention-getting blink amplitude (the percentage of decrease in target brightness from a standard) and the interaction of blink amplitude with the other blink characteristics mentioned above. Thirty-six participants were asked to locate and select blinking blocks of text on a simulated air traffic control display to examine the interaction of blink frequencies, amplitudes, and duration with size of text. Our results support the use of amplitudes 75% or greater combined with frequencies from 2 to 4 Hertz and text size 0.15 inch or greater for optimum highlighting value in visual search tasks.

DTIC

*Air Traffic Control; Human Factors Engineering; Display Devices*

**19990046605** NASA Goddard Space Flight Center, Greenbelt, MD USA

**A Self-Tuning Kalman Filter for Autonomous Navigation Using the Global Positioning System (GPS)**

Truong, Son H., NASA Goddard Space Flight Center, USA; 1999; In English; Flight Mechanics, 18-20 May 1999, Greenbelt, MD, USA; Copyright; Avail: Issuing Activity, Hardcopy, Microfiche

Most navigation systems currently operated by NASA are ground-based, and require extensive support to produce accurate results. Recently developed systems that use Kalman filter and GPS (Global Positioning Systems) data for orbit determination greatly reduce dependency on ground support, and have potential to provide significant economies for NASA spacecraft navigation. These systems, however, still rely on manual tuning from analysts. A sophisticated neuro-fuzzy component fully integrated with the flight navigation system can perform the self-tuning capability for the Kalman filter and help the navigation system recover from estimation errors in real time.

Author

*Space Navigation; Autonomous Navigation; Global Positioning System; Control Systems Design; Automatic Flight Control*

*Includes aircraft simulation technology.*

**19990045624** Kyushu Univ., Faculty of Engineering, Fukuoka, Japan

**Introduction of Group Iteration and its Application to Designing of UAVs**

Nagasaki, Shuji, Kyushu Univ., Japan; Asano, Tetsuya, Kyushu Univ., Japan; Sakurai, Akira, Kyushu Univ., Japan; Technology Reports of Kyushu University; Jul. 1998; Volume 71, No. 4, pp. 251-254; In Japanese; See also 19990045622; No Copyright; Avail: CASI; A01, Hardcopy; A03, Microfiche

A new method of global optimization called GI (Group Iteration) is proposed. It is an extension of GA (Genetic Algorithm) with conserving some of the key features and utilizes generalized iterative scheme without being limited by the genetic metaphor of GA. This new method is applied to a problem of simplified conceptual design of a UAV (Unmanned Aerial Vehicle), and GI is an effective optimization method for non-analytic, complicated problems.

Author

*Design Analysis; Procedures; Technology Assessment; Optimization*

**19990045847** European Organization for the Safety of Air Navigation, Bretigny-sur-Orge France

**Aircraft Performance Summary Tables for the Base of Aircraft Data (BADA). Revision 3.1**

Baulleret, P.; Nov. 1998; 92p; In English

Report No.(s): PB99-136194; EEC/NOTE-27/98; Copyright; Avail: National Technical Information Service (NTIS), Microfiche

A set of aircraft performance summary tables are presented for the 67 aircraft types modelled by the Base of Aircraft Data (BADA) Revision 3.1. For each aircraft type, the performance tables specify the true air speed, rate of climb/descent and fuel flow for conditions of climb, cruise and descent at various flight levels. The performance figures contained within the tables are calculated based on a total energy model and BADA 3.1 performance coefficients.

NTIS

*Aircraft Performance; Aircraft Models; Flight Operations; Real Time Operation; Data Bases*

**19990045848** European Organization for the Safety of Air Navigation, Bretigny-sur-Orge France

**Revision Summary Document for the Base of Aircraft Data (BADA). Revision 3.1**

Baulleret, P.; Nov. 1998; 36p; In English

Report No.(s): PB99-136186; EEC/NOTE-26/98; Copyright; Avail: National Technical Information Service (NTIS), Microfiche

This Revision Summary Document (RSD) describes all changes made to BADA files in Revision 3.1 since the previous release, Revision 3.0. Configuration management procedures for BADA trace all changes through Configuration Change Orders (CCOs). The RSD thus presents a list of all 12 CCOs implemented for BADA 3.1 along with a description for each CCO.

NTIS

*Data Bases; Aircraft Configurations; Aircraft Models*

**19990045905** NASA Lewis Research Center, Cleveland, OH USA

**Load Distribution in Transmissions "Split" La Ripartizione del Carico Nelle Transmissioni "Split"**

Krantz, Timothy L., NASA Lewis Research Center, USA; Delgado, Irebert R., NASA Lewis Research Center, USA; Organi di Transmissione; January 1998, No. 1, pp. 64-72; In Italian; Power Transmission and Gearing, 1996, Unknown

Contract(s)/Grant(s): RTOP 581-20-13; Copyright; Avail: Issuing Activity, Hardcopy, Microfiche

The transmission system of a helicopter must meet particularly critical requirements. It must transmit engine power to the rotor, at the same time ensuring a typical speed reduction of 60 to 1. It must also be safe, reliable, light, and reach a high level of performance while, at the same time, it must produce few vibrations and little noise. Helicopter transmissions have achieved high-level performances thanks to the combination of analyses, experiments, and the application of practical field experience. However, the new generation of helicopters will require transmission systems that are even safer, lighter, less noisy, and more reliable.

Author

*Helicopters; Rotors; Transmissions (Machine Elements); Loads (Forces); Helicopter Design; Gears; Torque*



**19990046080** NASA Ames Research Center, Moffett Field, CA USA

**System and Method for Finite Element Simulation of Helicopter Turbulence**

McFarland, R. E., Inventor, NASA Ames Research Center, USA; Dulsenberg, Ken, Inventor, NASA Ames Research Center, USA; Jan. 19, 1999; 18p; In English

Patent Info.: Filed 22 Apr. 1996; NASA-Case-ARC-14053-1-LE; US-Patent-5,860,807; US-Patent-Appl-SN-656145; No Copyright; Avail: US Patent and Trademark Office, Hardcopy, Microfiche

The present invention provides a turbulence model that has been developed for blade-element helicopter simulation. This model uses an innovative temporal and geometrical distribution algorithm that preserves the statistical characteristics of the turbulence spectra over the rotor disc, while providing velocity components in real time to each of five blade-element stations along each of four blades. for a total of twenty blade-element stations. The simulator system includes a software implementation of flight dynamics that adheres to the guidelines for turbulence set forth in military specifications. One of the features of the present simulator system is that it applies simulated turbulence to the rotor blades of the helicopter, rather than to its center of gravity. The simulator system accurately models the rotor penetration into a gust field. It includes time correlation between the front and rear of the main rotor, as well as between the side forces felt at the center of gravity and at the tail rotor. It also includes features for added realism, such as patchy turbulence and vertical gusts in to which the rotor disc penetrates. These features are realized by a unique real time implementation of the turbulence filters. The new simulator system uses two arrays one on either side of the main rotor to record the turbulence field and to produce time-correlation from the front to the rear of the rotor disc. The use of Gaussian Interpolation between the two arrays maintains the statistical properties of the turbulence across the rotor disc. The present simulator system and method may be used in future and existing real-time helicopter simulations with minimal increase in computational workload.

Official Gazette of the U.S. Patent and Trademark Office

*Helicopters; Turbulence; Real Time Operation; Computerized Simulation; Finite Element Method*

**19990046090** NASA Langley Research Center, Hampton, VA USA

**Non-Linear Finite Element Modeling of THUNDER Piezoelectric Actuators**

Taleghani, Barmac K., Army Research Lab., USA; Campbell, Joel F., Science Applications International Corp., USA; May 1999; 18p; In English

Contract(s)/Grant(s): RTOP 522-32-41-01

Report No.(s): NASA/TM-1999-209322; L-17834; NAS 1.15:209322; ARL-TR-1977; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

A NASTRAN non-linear finite element model has been developed for predicting the dome heights of THUNDER (THin Layer UNimorph Ferroelectric DrivER) piezoelectric actuators. to analytically validate the finite element model, a comparison was made with a non-linear plate solution using Von Karmen's approximation. A 500 volt input was used to examine the actuator deformation. The NASTRAN finite element model was also compared with experimental results. Four groups of specimens were fabricated and tested. Four different input voltages, which included 120, 160, 200, and 240 Vp-p with a 0 volts offset, were used for this comparison.

Author

*Finite Element Method; Mathematical Models; Piezoelectricity; Actuators; Aircraft Design*

**19990046096** Boeing Co., Canoga Park, CA USA

**F/A-18E/F High AOA Testing Update**

Madenwald, Fred, Boeing Co., USA; Niewoehner, Rob, Naval Air Station, USA; Heller, Mike, Boeing Co., USA; 1997 Report to the Aerospace Profession: Forty First Symposium Proceedings; Sep. 1997, pp. 5-13; In English; See also 19990046095; Copyright; Avail: Issuing Activity (Society of Experimental Test Pilots, Lancaster, CA), Hardcopy, Microfiche

The high angle of attack control laws for the F/A-18E/F were designed with several goals in mind. Some goals were requirements - spelled out in the military specification. Other goals were considered "stretch goals" - goals above and beyond what were called out in the specification. The general design goals for the E/F were: (1) Highly Departure Resistant - Ensure aircraft controllability for all possible control inputs. Controllability should not come at the expense of performance. A variety of specifications require departure resistance mainly up to stall AOA. (2) Roll Performance with Centerline Tank as Good as F/A-18C without Tank - This is a specification. Time-to-90°-bank values for various angles of attack at 19 .6M/25K were specified based on F/A-18C performance without a centerline tank. (3) No AOA/CG Placards for Air-to-Air Loadings - The C/D aircraft have AOA placards as a function of CG location and loading - primarily to guard against high angle of attack hang-up and falling leaf motion. The specification states that the E/F should be no more restrictive than the C/D. The design goal was to have no restrictions. (4) Relaxed AOA/CG Placards for Air-to-Ground Loadings - As stated above, the specification states that the E/F shall be no more restrictive

than the C/D. The goal for Air-to-Ground loadings was to have an expanded AOA envelope compared to the C/D, ultimately having no AOA restriction. (5) No Falling Leaf Motion - The C/D aircraft is prone to falling leaf motion, which is characterized by in-phase roll/yaw motion that produces a strong nose-up coupling moment. At aft CG, the C/D aircraft have been known to have severely delayed recoveries. The goal for the E/F was to eliminate this mode. (6) Good Spin Characteristics - The specification states that a simple recovery technique be adequate for spin recovery. The goal for the E/F was to have similar spin characteristics to the C/D, which exhibits good recovery characteristics. (7) Better Lateral Weight Asymmetry Envelope than the C/D - The specification states that the E/F shall be no less restrictive than the C/D. The E/F goal was to have a substantially improved AOA/asymmetry envelope, with unlimited maneuvering to 12,000 ft-lbs compared to the C/D unlimited maneuvering level of 6,000 ft-lbs. and (8) No Two-Place Restrictions - The specification states that the two-place aircraft shall not incur Mach/AOA restrictions as they exist on the B/D aircraft, which was the E/F goal.

Author

*Angle of Attack; Design Analysis; Specifications; Controllability; Experiment Design*

**19990046097** Naval Air Station, Patuxent River, MD USA

#### **F/A-18E/F Initial Sea Trials**

Gurney, Tom, Naval Air Station, USA; Morley, Frank, Naval Air Station, USA; 1997 Report to the Aerospace Profession: Forty First Symposium Proceedings; Sep. 1997, pp. 14-20; In English; See also 19990046095; Copyright; Avail: Issuing Activity (Society of Experimental Test Pilots, Lancaster, CA), Hardcopy, Microfiche

The objective of the Initial Sea Trials (IST) phase of F/A-18E/F Engineering and Manufacturing Development (EMD) was to provide an early assessment of the airplane in the aircraft carrier environment. The combined military specification (addendum 131 and ML-D-8708B) outlined the shorebased and shipboard tests required for completion of IST. Shorebased testing comprised the majority of work and included evaluation of PA flying qualities, high angle of attack characteristics, field of view and hook to eye measurements, suitability of recommended approach angle of attack and associated airspeeds, approach, bolter and waveoff performance characteristics, trim transients with configuration changes, single engine and degraded engine handling qualities and performance, catapult launch and arrested landing characteristics and loads, and ground handling qualities. Shipboard testing included evaluation of catapult launch flyaway characteristics at various CG locations and trim conditions, flying qualities and performance characteristics during approach at different wind over deck conditions and various CG locations, and flight deck and hangar deck handling and support equipment compatibility. Aircraft F1, the first two-seater produced, was assigned as the carrier suitability test airplane. Shipboard testing was conducted aboard USS JOHN C. STENNIS (CVN 74) from 18 to 23 January, 1997. The final demonstration point for the carrier suitability clean aircraft loading was completed on 9 June 1997.

Author

*Assessments; Flight Characteristics; Aerodynamic Characteristics; Product Development; Specifications*

**19990046098** NASA Johnson Space Center, Houston, TX USA

#### **A Low-Cost Design and Flight Test of the T-38 Inlet**

Johnson, Greg, NASA Johnson Space Center, USA; Ess, Robert, NASA Johnson Space Center, USA; 1997 Report to the Aerospace Profession: Forty First Symposium Proceedings; Sep. 1997, pp. 21-45; In English; See also 19990046095; Copyright; Avail: Issuing Activity (Society of Experimental Test Pilots, Lancaster, CA), Hardcopy, Microfiche

An inlet redesign of the T-38 was completed and flight tested by NASA Johnson Space Center (JSC), Houston Texas. The redesign will allow full gross weight takeoffs from high altitude airports such as El Paso, Texas (ELP) with runway temperatures up to 99 degrees F, an increase of 9 degrees F over the current performance. This project was completed in-house using innovative test techniques. The static thrust of the T-38 was increased 20% with this new inlet.

Author

*Flight Tests; T-38 Aircraft; Supersonic Inlets*

**19990046100** Sino Swearingen Aircraft Co., San Antonio, TX USA

#### **Status of the SJ30-2: Flight Test Overview**

Beeler, Carroll, Sino Swearingen Aircraft Co., USA; 1997 Report to the Aerospace Profession: Forty First Symposium Proceedings; Sep. 1997, pp. 63-102; In English; See also 19990046095; Copyright; Avail: Issuing Activity (Society of Experimental Test Pilots, Lancaster, CA), Hardcopy, Microfiche

We are in the midst of a fairly aggressive flight test development program and this paper is a brief overview of the program to date. The SJ30-2 is being developed as a light weight, entry level, efficient business class jet aircraft. The current configuration is for 1 or 2 pilots and cabin seating for 4 or 5. The aircraft will be certificated for single pilot operation. The original SJ30 prototype aircraft (Serial 001A) flew its first flight on November 11, 1990. The aircraft underwent a 400+ hour research program consisting

of systems development, envelope expansion, handling qualities and performance evaluation. We will discuss the prototype, it's recent modification history and the test program to date.

Author

*Flight Tests; Systems Engineering; Performance Tests; Evaluation*

**19990046101** Aerospace Industrial Development Corp., Taichung, Taiwan, Province of China

**IDF Flight Test Program Overview**

Chu, Charles, Aerospace Industrial Development Corp., Taiwan, Province of China; Wueng, Fwu-Lai, Aerospace Industrial Development Corp., Taiwan, Province of China; 1997 Report to the Aerospace Profession: Forty First Symposium Proceedings; Sep. 1997, pp. 103-150; In English; See also 19990046095; Copyright; Avail: Issuing Activity (Society of Experimental Test Pilots, Lancaster, CA), Hardcopy, Microfiche

The Indigenous Defensive Fighter (IDF) is the first advanced fighter built in Taiwan, Republic of China, specifically designed to take advantage of the most advanced technology available including both digital flight control system and advanced avionics system. Over 2600 test flights have been conducted during the last 8 years using four full scale development test aircraft. With so much new design technology and the need for new test flight concepts to be developed, it was inevitable that several design faults would and were identified during flight test maneuvers. This resulted in both the flight test team and the designer group benefiting greatly from the experience gained in system design / integration, flight test planning and, nor least of all, problem solving.

Author

*Flight Tests; Full Scale Tests; Flight Control*

**19990046103** Westland Helicopters Ltd., Yeovil, UK

**EH101: Airfield Performance Testing of a Three-Engine Helicopter**

Swales, Michael R., Westland Helicopters Ltd., UK; 1997 Report to the Aerospace Profession: Forty First Symposium Proceedings; Sep. 1997, pp. 183-210; In English; See also 19990046095; Copyright; Avail: Issuing Activity (Society of Experimental Test Pilots, Lancaster, CA), Hardcopy, Microfiche

In November 1994, the EH101 was the first helicopter to achieve simultaneously a preliminary Type Certification from three airworthiness agencies, the UK CAA, the FAA and the Italian RAI. In continuation of the full certification process, an airfield performance trial was conducted at the EH101 production facility of Vergiate, near Milan, Italy during Summer 1996. Fifty five hours were flown evaluating the handling and performance of the helicopter in Category A take off and landing profiles and in ground level heliport operations. This paper discusses these tests, emphasising the idiosyncrasies of the three engine configuration and the choice of techniques flown. Results are presented which match a mathematical model from a Helicopter Airfield Performance Simulation (HAPS) program to actual performance achieved. After a satisfactory correlation is obtained, then HAPS will be used to generate the Flight Manual dynamic performance charts.

Author

*Helicopter Performance; Mathematical Models; Performance Tests; Aircraft Reliability; Flight Characteristics*

**19990046105** Lockheed Aeronautical Systems Co., Thousand Oaks, CA USA

**Automatic VMC Protection in the C-130J**

Schaefer, Lyle H., Lockheed Aeronautical Systems Co., USA; Roberts, Wayne, Lockheed Aeronautical Systems Co., USA; 1997 Report to the Aerospace Profession: Forty First Symposium Proceedings; Sep. 1997, pp. 235-252; In English; See also 19990046095; Copyright; Avail: Issuing Activity (Society of Experimental Test Pilots, Lancaster, CA), Hardcopy, Microfiche

The C-130J design has incorporated many new features which will make a positive contribution to flight safety. Among those features are dual heads up display system (HUD's), an angle of attack based stall warning and prevention system, aural and visual alerts for excessive sideslip, a ground proximity warning system, a predictive windshear alerting system, as well as takeoff configuration alerts. In addition to all these, the C-130J possess a unique system which has the potential of making a major contribution to flight safety; an Automatic Thrust Control System (ATCS). This paper will explain how this ATCS system functions how it was developed, and will define the contribution the system makes to both performance and safety.

Author

*Flight Safety; Automatic Control; Display Devices; Angle of Attack; Warning Systems; Thrust Control*

**19990046111** Boeing AS and T Phantom Works, Saint Louis, MO USA

**Flight Testing the X-36: The Test Pilot's Perspective**

Walker, Laurence A., Boeing AS and T Phantom Works, USA; 1997 Report to the Aerospace Profession: Forty First Symposium Proceedings; Sep. 1997, pp. 338-348; In English; See also 19990046095; Copyright; Avail: Issuing Activity (Society of Experimental Test Pilots, Lancaster, CA), Hardcopy, Microfiche

From the beginnings of aviation, designers have sought ways to create faster, lighter, more maneuverable designs. Tailless designs have had the promise of reducing structural weight, aerodynamic drag and cost, but at the increased complexity of a complicated control system and non-traditional control surfaces. Recently, stealth has also become an important design consideration. Fortunately two key enabling technologies have made a blend of these attributes possible. These are digital flight control technology and the vast advances in computational analysis which permit integration of low observable technologies and advanced aerodynamic design. The X-36 represents a radical integration of these technologies into a practical research aircraft.

Author

*X-36 Aircraft; Aerodynamic Drag; Control Surfaces; Flight Tests; Structural Weight; Maneuverability*

**19990046112** Cessna Aircraft Co., Wichita, KS USA

**Citation X: Development and Certification of a 0.9 Mach+ Business Jet**

Schlegel, Mark O., Cessna Aircraft Co., USA; 1997 Report to the Aerospace Profession: Forty First Symposium Proceedings; Sep. 1997, pp. 349-368; In English; See also 19990046095; Copyright; Avail: Issuing Activity (Society of Experimental Test Pilots, Lancaster, CA), Hardcopy, Microfiche

The Cessna Citation X (CE750) was announced by Cessna Chairman Russ Meyer during a press conference at the 1990 National Business Aircraft Association (NBAA) convention. The Citation X was to be the first business jet to cruise at 0.88 Mach, with a maximum speed of 0.90 Mach. The aircraft description and flight test program highlights are presented.

Derived from text

*Cessna Aircraft; Flight Tests; Mach Number; Aircraft Performance*

**19990046113** Sikorsky Aircraft, Stratford, CT USA

**RAH-66 Comanche Flight Test Progress Report**

Stiles, Lorren, Sikorsky Aircraft, USA; Murrell, Reginald, Boeing Helicopter Co., USA; Armbrust, John, Department of the Army, USA; 1997 Report to the Aerospace Profession: Forty First Symposium Proceedings; Sep. 1997, pp. 369-392; In English; See also 19990046095; Copyright; Avail: Issuing Activity (Society of Experimental Test Pilots, Lancaster, CA), Hardcopy, Microfiche

The Comanche has been in flight test status since its First Flight on 4 Jan. 96. After an extensive update following First Flight, testing resumed on Aug. 24, 1996 and has continued to the present time. Significant progress has been made in shakedown of the structural and propulsion envelopes, development of the fly-by-wire control system and systems integration.

Author

*Flight Tests; Vibration Effects; Helicopter Control*

**19990046193** National Aerospace Lab., Amsterdam, Netherlands

**Residual Strength Test on Stiffened Panels with Multiple-Site Damage Final Report**

tenHoeve, H. J.; Michielsen, A. L. P. J.; Vlieger, H.; Schra, L.; Feb. 1999; 86p; In English  
Report No.(s): PB99-139586; NLR-CR-96792L; No Copyright; Avail: CASI; A05, Hardcopy; A01, Microfiche

In Federal Aviation Administration and the Netherlands Department of Civil Aviation (FAA/RLD) collaboration, residual strength tests were carried out on stiffened panels with multiple-site damage (MSD). The main purpose of this test program was to generate experimental data to verify tools to predict the residual strength of such panels. In this report these tests are described and the results are presented in such a way they can be used to verify new and existing models.

NTIS

*Civil Aviation; Residual Strength; Damage; Stiffness; Panels; Flight Tests*

**19990046214** National Aerospace Lab., Tokyo Japan

**Structural Weight Estimation Method for Winged Vehicles**

Kanno, Y.; Iwasaki, K.; Aug. 1998; 54p; In Japanese; Portions of this document are not fully legible  
Report No.(s): PB99-141509; NAL-TR-1351; Copyright; Avail: National Technical Information Service (NTIS), Microfiche

This research aims at developing a structural weight estimation computer program which is useful for parametric studies, etc. The weight estimation methods uses the process of piling up structural elements' (skin, stinger, etc) weights which are determined



by strength analysis. The input parameters are vehicle geometry, structure arrangements, load conditions and material data. This weight estimation method is compared to an FEM weight analysis with the same condition. The estimated weight difference between this method and FEM weight analysis is about 15%. This weight estimation computer program can calculate the structural weight's change against the input parameter's change quickly. Therefore, this program is useful not only for one point weight estimation but also for parametric studies.

NTIS

*Structural Weight; Weight Measurement; Computer Programs; Estimating*

**19990046352** Defence Evaluation Research Agency, Structural Materials Centre, Farnborough, UK

**An Overview of PEP WG28: Recommended Practices for Monitoring Gas Turbine Engine Life Consumption**

Harrison, G. F., Defence Evaluation Research Agency, UK; November 1998; 12p; In English; See also 19990046347; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

The terms of reference for PEP WG28 provide the framework for ongoing activities. The Working Group has been tasked to examine methodologies used to predict engine life consumption rates for currently deployed fleets and to understand the limitations of these methods. Within this task, consideration has been given to fracture-critical components of the propulsion system namely, discs, impellers and spacers in both hot and cold ends. Methodologies by which mission profiles are translated into low cycle fatigue (LCF) life consumption have been addressed. The various operational usage data acquisition techniques such as gating, and continuous recording also form part of the study. Each methodology has been elaborated with respect to its development and validation and to its capabilities in operational usage tracking, in identifying parts life consumption and in application to maintenance strategies. Experience gained using the various methodologies and strategies is documented and major practices identified. Where these conflict or are not congruent, each is discussed. Recommendations for future development are included as appropriate. Primary emphasis of the effort focused on the user viewpoint by addressing the benefits of fleet-wide usage monitoring, the experience from actual field use and the impact of manufacturing quality standards. The study is aimed at fighter aircraft, helicopters and military transport however, Civil experience is also taken into account.

Author

*Gas Turbine Engines; Mission Planning; Monitors; Life (Durability); Fatigue Life; Fracturing*

**19990046353** Motoren- und Turbinen-Union G.m.b.H., Dept. TPM, Munich, Germany

**Methods of Modern Lifting Concepts Implemented in On-Board Life Usage Monitoring Systems**

Broede, Juergen, Motoren- und Turbinen-Union G.m.b.H., Germany; Koehl, Manfred, Motoren- und Turbinen-Union G.m.b.H., Germany; November 1998; 10p; In English; See also 19990046347; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

Modern lifting concepts for fracture critical parts include safe crack initiation life and safe crack propagation life. In military aero engine applications, a portion of the safe crack propagation life is more and more utilized to extend the usage period beyond the limits set by the concept of safe crack initiation life. To really use the benefits of such life extension without reduction of flight safety, it is essential that all engines involved are monitored with respect to individual life consumption. Thus, on-board life usage monitoring systems need to address the crack propagation phase in the same manner as the crack initiation phase. It is shown how the calculations of fracture mechanics parameters and the resulting crack propagation process are integrated into the algorithms of on-board life usage monitoring software. Applicability of the methods is underlined by results obtained with OLMOS - the on-board life usage monitoring system of the German Tornado fleet.

Author

*Flight Safety; Crack Propagation; Aircraft Engines; Life (Durability); Procedures*

**19990046354** Cranfield Univ., Bedford, UK

**The Contribution of Health and Usage Monitoring Systems to Calculations of Damage State and Future Life of Helicopter Components Under Safe Life and Damage Tolerant Designs**

Irving, P. E., Cranfield Univ., UK; Hudson, R. A., Cranfield Univ., UK; November 1998; 12p; In English; See also 19990046347; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

Techniques for calculation of fatigue damage on rotor components of helicopters are assessed and investigated using service flight load data. Fatigue damage for the dog bone blade linkage on the GKN-Westland Lynx has been calculated from loads measured during flight for a range of maneuvers. It is found that variability of non-zero damage for individual maneuvers is between 100 and 1,000 times. The difference in damage per flight hour between worst case damage and an upper limit for the most probable damage is a factor of 7.5. The contribution to damage of the loads scatter factor of 1.2 is quantitatively assessed. Finally the propor-

tions of damage which occurs during a flight within maneuvers and that which is between maneuvers has been investigated. The results are discussed for both flight load synthesis and flight condition recognition approaches to indirect FUMS techniques.

Author

*Health; Monitors; Computation; Life (Durability); Helicopters; Structural Members*

**19990046355** Naval Air Warfare Center, Propulsion and Power Dept., Patuxent River, MD USA

**SH-60 Helicopter Integrated Diagnostic System (HIDS) Program Experience and Results of Seeded Fault Testing**

Hess, Andrew J., Naval Air Warfare Center, USA; Hardman, Bill, Naval Air Warfare Center, USA; Neubert, Chris, Naval Air Warfare Center, USA; November 1998; 22p; In English; See also 19990046347; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

The evolution of automated diagnostic systems for helicopter mechanical systems has been aided by a Navy program of systematic testing of drive train components having known anomalies (seeded faults) while simultaneously executing a suite of diagnostic techniques to identify and classify the mechanical anomalies. This program, called the Helicopter Integrated Diagnostic System (HIDS) has been carried out using an iron bird test stand (SH-60) at NAWC - Trenton, and SH-60B/F flight vehicles at NAWC - Patuxent River. The SH-60 HIDS program has been the Navy's cornerstone effort to develop, demonstrate, and justify integrated mechanical diagnostic system capabilities for its helicopter fleets. The objectives of the program were to: 1. Acquire raw data for multiple cases of "good" and seeded fault mechanical components on a fully instrumented drive train to support the evaluation of diagnostic algorithms and fault isolation matrices. Data is being acquired from 32 vibration channels simultaneously at 100 kHz per channel while a continuous usage monitoring system records parametric steady state data from the power plant and airframe. 2. Analyze vibration and other diagnostic indicators to evaluate sensitivity and performance of all available diagnostic methods when analyzing well-documented parts. Evaluate relative effectiveness of these various diagnostic methods, indicators, and their associated algorithms to identify and optimize sensor location combinations. 3. Demonstrate the ability to integrate and automate the data acquisition, diagnostic, fault evaluation and communication processes in a flightworthy system. 4. Integrate and evaluate comprehensive engine monitoring, gearbox and drivetrain vibration diagnostics, advanced oil debris monitoring, inflight rotor track and balance, parts life usage tracking, automated flight regime recognition, power assurance checks and trending, and automated maintenance forecasting in a well coordinated on-board and ground-based system. 5. Provide an extensive library of high quality vibration data on baseline and seeded fault components. This data can be made available to anyone wanting to prove their diagnostic techniques or develop new capability. 6. Provide a "showcase", state-of-the-art fully functional Integrated Mechanical Diagnostic system to act as a catalyst demonstration which might lead to interest in a fleet wide production application. This paper will describe the overall program, the goals and objectives, the facilities used, the system evaluated, the accomplishments and the results and conclusions obtained to date. The results of extensive gearbox and powertrain "seeded fault" testing will be presented. Lessons learned which can be applied to future Helicopter Usage Monitoring Systems (HUMS) and/or Integrated Mechanical Diagnostic (IMD) systems will also be discussed.

Author

*Automatic Control; Diagnosis; Rotary Wings; Rotor Aerodynamics; Performance Tests; Data Acquisition*

**19990046357** Federal Aviation Administration, Hampton, VA USA

**HUMS Loads Monitoring and Damage Tolerance: An Operational Evaluation**

Basehore, Michael L., Federal Aviation Administration, USA; Dickson, William, Textron Bell Helicopter, USA; November 1998; 14p; In English; See also 19990046347; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

This paper describes the results of a research program to evaluate structural usage monitoring and damage tolerance methodology using data collected concurrently during a helicopter flight program. The helicopter, a Bell Model 412 equipped with a Health and Usage Monitoring System (HUMS) and data recorder, was operated by Petroleum Helicopters Inc. (PHI) during the 1996 Summer Olympic Games in Atlanta, Georgia, as a part of Project HeliSTAR. This effort was conducted by Bell Helicopter Textron Inc. (BHTI) under the cognizance of the Federal Aviation Administration (FAA), the U.S. Army, and NASA. The helicopter was flown in what is referred to in this paper as the Atlanta Short Haul Mission (ASHM). This mission involved numerous short flights to pick up and deliver packages and freight. Data recorded during the period, together with pilot flight records and maintenance records were furnished by PHI to BHTI for analysis. The results of the analysis of the ASHM were compared to results from an offshore oil support Gulf Coast Mission (GCM) which involved longer level flights at cruise airspeed. The purpose of the program was to acquire usage data for the ASHM and to perform component fatigue life calculations and damage tolerance evaluations for selected critical dynamic components, referred to here as Principal Structural Elements (PSE's). Although the usage was more severe for the ASHM than the GCM, the results of the comparison showed that usage monitoring would provide benefits in extending retirement times or inspection intervals, compared to certification, especially if high/low altitude effects were considered. In addition to usage monitoring evaluations, guidelines for HUMS certification are discussed along with simpli-

fied "mini-HUMS" approaches to provide low cost systems with high return on investment. The lives and inspection intervals determined for purposes of this study should not be used to draw any conclusions concerning certification or continued airworthiness of the Model 412 helicopter.

Author

*Monitors; Research; Evaluation; Loads (Forces); Tolerances (Mechanics); Fatigue (Materials)*

**19990046358** Industrial Marine Products Group Ltd., Aerospace Div., Halifax, Nova Scotia Canada

**CP140 (P3) Structural Data Recording System**

Oore, M., Industrial Marine Products Group Ltd., Canada; Crocker, D. H., National Defence Headquarters, Canada; November 1998; 12p; In English; See also 19990046347; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

Each of the Canadian CP140/CP140A aircraft, variants of the Lockheed P-3C, has been equipped with a Structural Data Recording System (SDRS) to facilitate Individual Aircraft Tracking (IAT). One of the objectives of the system is to provide usage monitoring data that will enable the Canadian Forces (CF) to quantify individual aircraft fatigue usage and crack growth rates from which optimized inspection times can be calculated. Thus inspection frequency and costs can be reduced while the safety of the aircraft is ensured. This article provides a brief description of the SDRS and related experience acquired during the five years of system usage and data collection. An overview of the parameters recorded by the SDRS is presented as well as examples of data recorded in flight and their significance. Strain sensor recording rise/fall criteria are discussed in the context of minimizing the volume of recorded data while capturing significant data. A rise/fall criteria sensitivity study, conducted to optimize selection of the triggering gate value, is presented. Since the SDRS zeros strain sensor readings at the beginning of each flight, a strain offset determination method was developed in order to calculate absolute strain values. This method has been substantiated by calibration tests that included validation of a Finite Element (FE) model of the wing and verification of the SDRS strain measuring system. Studies performed to assess the adequacy of the SDRS strain resolution are also presented. Overall it is demonstrated that SDRS data can be used to generate sufficiently accurate stress spectra for fatigue and crack growth analyses.

Author

*Safety; Data Recording; Data Acquisition; Crack Propagation; Aircraft Detection; Inspection; Dynamic Structural Analysis*

**19990046359** Sabena Belgian World Airlines, Brussels, Brabant, Belgium

**NATO TCA Cycle Counting Study and its Applications**

Moyson, E., Sabena Belgian World Airlines, Brussels, Belgium; November 1998; 8p; In English; See also 19990046347; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

Three former Sabena 707-329c's were modified and transferred to NATO as AWACS trainer and transport aircraft. Compared to commercial B707's the Trainer Cargo Aircraft (TCA) accumulate more cycles including touch and go landings. One engine out landings and aerial refueling training are significantly more damaging in some structural areas. For operational flexibility, no mission profiles are defined. TCA missions are variable combinations of different mission events. Available data in the area of loads, stresses, fatigue and fracture mechanics are used to develop a comparative crack growth relation between TCA events and commercial B707-320c flights. After adjustment of cycle intervals i.a.w. the cycle counting study, all structural inspection requirements were consolidated in a calendar based integrated maintenance program. The design service objectives are extended and major structural modifications can significantly be postponed.

Author

*Crack Propagation; Damage; Education; Fatigue (Materials); Training Devices; Transport Aircraft; Research*

**19990046360** National Aerospace Lab., Structures and Materials Div., Amsterdam, Netherlands

**F-16 Loads/Usage Monitoring**

Spiekhout, D. J., National Aerospace Lab., Netherlands; November 1998; 10p; In English; See also 19990046347; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

Load monitoring of the F-16 fleet of the RNLAf has been carried out by NLR as a routine program since 1990. At that time the old system was replaced by an electronic device capable of analysing in flight the signal of a strain gage bridge. In later years, updates of the hardware have been implemented in order to record also some flight and engine parameters. Furthermore, collecting of administrative data has been integrated in the routine RNLAf maintenance debriefing procedures. In recent years development of a complete new load monitoring system took place. This system is fully integrated in the operational- and maintenance- proce-

dures of the RNLAf. Main characteristics are an increase of the number of strain gage bridges to five and a fleet wide implementation. Besides flight parameters, engine and avionics parameters are being measured. Ground stations for data handling are located at the squadrons and at NLR. by using up to date data base management programs, results are presented to the RNLAf on a weekly basis.

Author

*Loads (Forces); Monitors; F-16 Aircraft; Strain Gages*

**19990046361** National Defence Headquarters, Directorate of Technical Airworthiness, Ottawa, Ontario Canada

**CC130 Data Analysis System for OLM/IAT**

vandenHoeven, A. M., National Defence Headquarters, Canada; November 1998; 8p; In English; See also 19990046347; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

The Canadian CC130 fleet was fitted with a Operational Loads Monitoring and Individual Aircraft Tracking (OLM/IAT) system to assess usage severity. This article details the project that assembled the system to analyze the data and interpret the trends of aircraft structural fatigue. The CC130 Data Analysis System (DAS) was developed to process and analyze both parametric and strain data and assess usage severity using a fracture mechanics basis. The DAS development included innovative ideas on processing complex aircraft loads data by using an "engineer in the loop" process. Quick look analysis was also enabled by pre-processing validation data and plotting all parameters. The transfer functions were developed using a finite element model and flight test calibration data. The fracture mechanics models were validated through a comprehensive coupon testing program. Fleet management tools were developed to allow component based tracking of inspection requirements, usage severity trending and prediction of future aircraft role assignments. The DAS system has provided a sound engineering solution to the problem of assessing operational loads data for the CC130. This paper concludes with some of the lessons learned in achieving a solution to integrating a new manner of processing OLM data.

Author

*Data Processing; Fatigue (Materials); Trends; Plotting; Mathematical Models; Fracture Mechanics; Flight Tests; Aircraft Structures*

**19990046362** Boeing North American, Inc., Seal Beach, CA USA

**Service Life Monitoring of the B-1B and the Impact on Flight Operations and Structural Maintenance**

Denyer, Anthony G., Boeing North American, Inc., USA; November 1998; 12p; In English; See also 19990046347; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

The paper reviews the B-1 B Bomber fleet monitoring program that records the service environment and tracks individual aircraft for potential damage. The entire 100 aircraft fleet was equipped with a solid state flight data recorder that monitors both flight parameters and loads. The paper will describe the onboard data collection system and outline the analytic tools used to translate the recorded data into inspection and maintenance requirements as well as assessing the economic life of the structure. The paper will compare service usage with the design specification usage showing that usage to date is significantly more severe than that for which the aircraft was designed. Due to the severity of the recorded usage data the entire structure was reanalyzed during the 1993 to 1995 time period with the results showing a reduction in the economic life and a potential need for a reduction in inspection intervals. Implemented and proposed actions to offset the impact of the current severity of flight operations are described. These include a review of the analytic methodology, continued individual aircraft monitoring, a test program to provide data in support of inspection intervals, proposed operational changes, analytical condition inspections and a revised fuel management schedule. Finally the paper will discuss the lessons learned in efficiently handling large quantities of recorded data and the importance of monitoring service usage for early detection of usage severity that will impact the structural integrity.

Author

*Life (Durability); Service Life; Monitors; B-1 Aircraft; Bomber Aircraft; Structural Failure; Maintenance; Data Acquisition*

**19990046363** British Aerospace Defence Ltd., Military Aircraft and Aerostructures, Preston, UK

**Eurofighter 2000: An Integrated Approach to Structural Health and Usage Monitoring**

Hunt, S. R., British Aerospace Defence Ltd., UK; Hebden, I. G., British Aerospace Defence Ltd., UK; November 1998; 12p; In English; See also 19990046347; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

This paper outlines the Structural Health Monitoring system being developed for Eurofighter 2000. The system is designed as an integral part of the avionics system, both on and off-aircraft, enabling the customer to perform fleet-wide monitoring of fatigue life and significant structural loading events.

Author

*Fatigue Life; Monitors; Structural Stability*



**19990046416** NASA Langley Research Center, Hampton, VA USA

**Modeling and Validation of a Navy A6-Intruder Actively Controlled Landing Gear System**

Horta, Lucas G., NASA Langley Research Center, USA; Daugherty, Robert H., NASA Langley Research Center, USA; Martinson, Voloria J., NASA Langley Research Center, USA; May 1999; 32p; In English

Contract(s)/Grant(s): RTOP 522-18-11-04

Report No.(s): NASA/TP-1999-209124; NAS 1.60:209124; L-17817; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

Concepts for long-range air travel are characterized by airframe designs with long, slender, relatively flexible fuselages. One aspect often overlooked is ground-induced vibration of these aircraft. This paper presents an analytical and experimental study of reducing ground-induced aircraft vibration loads by using actively controlled landing gear. A facility has been developed to test various active landing gear control concepts and their performance. The facility uses a Navy A6 Intruder landing gear fitted with an auxiliary hydraulic supply electronically controlled by servo valves. An analytical model of the gear is presented, including modifications to actuate the gear externally, and test data are used to validate the model. The control design is described and closed-loop test and analysis comparisons are presented.

Author

*Active Control; Control Theory; Landing Gear; Servomechanisms; Valves; Vibration; Mathematical Models; Control Systems Design; Dynamic Control; Dynamic Tests*

**19990046430** Naval Postgraduate School, Monterey, CA USA

**Naval Command and Control for Future UAVs**

Majewski, Stephen E.; Mar. 1999; 62p; In English

Report No.(s): AD-A361851; No Copyright; Avail: CASI; A04, Hardcopy; A01, Microfiche

The primary purpose of this thesis is to examine the requirements of naval command and control for future Unmanned Aerial Vehicles (UAV) and to propose solutions for current limitations. Currently, UAVs co-exist as a collection of independent systems that have poor interoperability and limited functionality beyond strategic reconnaissance. As UAVs mature, they will increasingly be deployed at the unit level and employed tactically, increasing the need for coordination and the dissemination of information. Command and control systems must evolve to keep pace with this development. A description of contemporary and proposed UAV systems is presented, and this Thesis uses a scenario to illustrate current limitations and develop the requirements for UAV command and control.

DTIC

*Pilotless Aircraft; Deployment; Command and Control*

**19990046485** Congressional Budget Office, Washington, DC USA

**Options for Enhancing the Department of Defense's Unmanned Aerial Vehicle Programs**

Sep. 1998; 80p; In English

Report No.(s): AD-A361671; No Copyright; Avail: CASI; A05, Hardcopy; A01, Microfiche

The Department of Defense spends about \$600 million a year on various programs to develop unmanned aerial vehicles (UAVs). Historically, however, the department has had trouble developing and fielding UAV systems. Currently, two UAVs have been deployed or are in production (Pioneer and Predator), and three more are in development (Outrider, Global Hawk, and Darkstar). This Congressional Budget Office (CBO) paper reviews the plans, requirements, and costs for the Department of Defense's UAV programs. It also examines five options intended either to address problems in those programs or to make greater use of UAVs' potential as cheap, unmanned reconnaissance systems. The analysis was requested by the Ranking Minority Member of the Senate Committee on Armed Services. In keeping with CBO's mandate to provide objective and nonpartisan analysis, this paper makes no recommendations.

DTIC

*Congressional Reports; Reconnaissance Aircraft; Pilotless Aircraft*

**19990046584** Defence Science and Technology Organisation, Aeronautical and Maritime Research Lab., Melbourne, Australia

**Workshop on Helicopter Health and Usage Monitoring Systems**

Forsyth, Graham F., Editor; Feb. 1999; 234p; In English, Feb. 1999, Melbourne, Australia

Report No.(s): AD-A361854; DSTO-GD-0197; DODA-AR-010-812; No Copyright; Avail: CASI; A11, Hardcopy; A03, Microfiche

Over the last 10 years, helicopter Health and Usage Monitoring Systems (HUMS) have moved from the research environment to being viable systems for fitment to civil and military helicopters. In the civil environment, the situation has reached the point

where it has become a mandatory requirement for some classes of helicopters to have HUMS fitted. Military operators have lagged their civil counterparts in implementing HUMS, but that situation appears set to change with a rapid increase expected in their use in military helicopters. A DSTO-sponsored Workshop was held in Melbourne, Australia, in February 1999 to discuss the current status of helicopter HUMS and any issues of direct relevance to military helicopter operations.

DTIC

*Military Helicopters; Aircraft Maintenance; Systems Health Monitoring*

**19990046618** Army Vehicle Technology Center, Hampton, VA USA

**Damage Tolerance Issues as Related to Metallic Rotorcraft Dynamic Components**

Everett, R. A., Jr., Army Vehicle Technology Center, USA; Elber, W., Army Vehicle Technology Center, USA; 1999; In English; Aging Systems: Application of Damage Tolerance Principles for Improved Airworthiness of Rotorcraft, 21-22 Apr. 1999, Corfu, Greece; Sponsored by North Atlantic Treaty Organization, Belgium; Copyright; Avail: Issuing Activity, Hardcopy, Microfiche

In this paper issues related to the use of damage tolerance in life managing rotorcraft dynamic components are reviewed. In the past, rotorcraft fatigue design has combined constant amplitude tests of full-scale parts with flight loads and usage data in a conservative manner to provide "safe life" component replacement times. In contrast to the safe life approach over the past twenty years the USA Air Force and several other NATO nations have used damage tolerance design philosophies for fixed wing aircraft to improve safety and reliability. The reliability of the safe life approach being used in rotorcraft started to be questioned shortly after presentations at an American Helicopter Society's specialist meeting in 1980 showed predicted fatigue lives for a hypothetical pitch-link problem to vary from a low of 9 hours to a high in excess of 2594 hours. This presented serious cost, weight, and reliability implications. Somewhat after the U.S. Army introduced its six nines reliability on fatigue life, attention shifted towards using a possible damage tolerance approach to the life management of rotorcraft dynamic components. The use of damage tolerance in life management of dynamic rotorcraft parts will be the subject of this paper. This review will start with past studies on using damage tolerance life management with existing helicopter parts that were safe life designed. Also covered will be a successful attempt at certifying a tail rotor pitch rod using damage tolerance, which was designed using the safe life approach. The FAA review of rotorcraft fatigue design and their recommendations along with some on-going U.S. industry research in damage tolerance on rotorcraft will be reviewed.

Author

*Helicopters; Research Aircraft; Tolerances (Mechanics); Damage*

## 06

### AIRCRAFT INSTRUMENTATION

*Includes cockpit and cabin display devices; and flight instruments.*

**19990045975** Civil Aeromedical Inst., Oklahoma City, OK USA

**A Usability Survey of Global Positioning System Avionics Equipment: Some Preliminary Findings Final Report**

Joseph, Kurt M., Civil Aeromedical Inst., USA; Nendick, Michael D., Newcastle Univ., Australia; Jahns, Dieter W., SynerTech Associates, USA; St. George, Ross, Civil Aviation Authority, New Zealand; March 1999; 12p; In English  
Report No.(s): DOT/FAA/AM-99/9; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

The rapid introduction of Global Positioning System (GPS) receivers for airborne navigation has outpaced the capacity of international aviation authorities to resolve human factors issues that concern safe and efficient use of such devices. Current certification technical standards appear to have had little influence on standardizing receiver architectures, interfaces, and operating manuals-despite evidence from research simulation and flight tests that lack of standardization may undermine safety. The present research used factor-analytic techniques to reduce 308 pilots' ratings from a 163-item survey to 24 factors. These factors are suitable for identifying human factors issues related to GPS receiver displays and controls, operating procedures, navigation performance, training, and other topical areas. Multivariate analysis of variance revealed that GPS experience and receiver type influenced pilot ratings for several of these factors. The results of this limited survey are consistent with previous research, and their application to certification procedures and standards is discussed.

Author

*Global Positioning System; Surveys; Standardization; Multivariate Statistical Analysis; Flight Simulation; Certification; Analysis of Variance; Air Navigation*

## 07

### AIRCRAFT PROPULSION AND POWER

*Includes prime propulsion systems and systems components, e.g., gas turbine engines and compressors; and onboard auxiliary power plants for aircraft.*

**19990046104** Alenia Aeronautica, Turin, Italy

#### **Initial Engine Relight Test on Eurofighter 2000**

Bragagnolo, N., Alenia Aeronautica, Italy; Ferretti, A., Alenia Aeronautica, Italy; Venanzetti, M., Italian Air Force, Italy; 1997 Report to the Aerospace Profession: Forty First Symposium Proceedings; Sep. 1997, pp. 211-231; In English; See also 19990046095; Copyright; Avail: Issuing Activity (Society of Experimental Test Pilots, Lancaster, CA), Hardcopy, Microfiche

The Eurofighter 2000 Programme is developed by a four Nations Consortium involving Germany, Italy, Spain and UK. The Flight Test Departments of the Eurofighter partners companies (ALN, BAe, CASA, DASA) have evolved a test program consisting of seven instrumented prototypes tasked with different test objectives and aiming to provide a Release to Service for the production Aircraft by the year 2001. Within the EF2000 program, the Defence Ministries of the four Nations tasked their Official Test Centers to assess the status of the program development. This lecture highlights the steps undertaken by Alenia, upon agreement with the Officials, on the subject of the integration of the new engine (EJ200, developed by the Engine Consortium Manufacturers, Eurojet) onto the Eurofighter 2000 Aircraft.

Author

*Prototypes; Engine Control; Management Planning*

**19990046356** Defence Evaluation Research Agency, Structural Materials Center, Farnborough, UK

#### **Development and Validation of Algorithms for Engine Usage Monitoring Systems**

Henderson, M. B., Defence Evaluation Research Agency, UK; Harrison, G. F., Defence Evaluation Research Agency, UK; November 1998; 10p; In English; See also 19990046347; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

The design techniques used to provide the required component life with the safety levels imposed by the regulatory authorities are discussed. The development and validation of materials algorithms to determine the rate at which this life is consumed under service usage for the usage recorders are described. For lifting highly stressed engine components two of the most important variables are the piece of material that an individual component is made from, and the way in which the engine is used. Engines contain a number of highly loaded parts which are only released for limited service usage. At the end of the design and development process each part is qualified to the extent that a service life is 'declared' by the design authority. When a component reaches this declared life it is withdrawn from use. Life limitation is based on assessment of the low cycle fatigue, thermal fatigue and/or creep service capability of the component under consideration and engine life consumption is based on the stresses, strains and temperatures experienced at critical areas depending on the mission profiles, engine intake conditions, individual pilot reactions and several other parameters.

Author

*Algorithms; Engine Inlets; Monitors; Service Life*

## 08

### AIRCRAFT STABILITY AND CONTROL

*Includes aircraft handling qualities; piloting; flight controls; and autopilots.*

**19990044103** Air Force Inst. of Tech., School of Engineering, Wright-Patterson AFB, OH USA

#### **Close Formation Flight Control**

Proud, Andrew W.; May 1999; 147p; In English

Report No.(s): AD-A361704; AFIT/GE/ENG/99M-24; No Copyright; Avail: CASI; A07, Hardcopy; A02, Microfiche

In this research the close formation flight control problem is addressed. The formation consists of a lead and wing aircraft, where the wing flies in close formation with the lead, such that the lead's vortices produce aerodynamic coupling effects, and a reduction in the formation's drag is achieved. A controller, i.e., a formation-hold autopilot for the wing aircraft, is designed such that the formation's geometry is maintained in the face of lead aircraft maneuvers. In the formation flight control system, the wing and lead aircraft dynamics are coupled due to kinematic effects, and, in the case of close formations, additional aerodynamic coupling effects are introduced. In the research these additional aerodynamic coupling effects are properly modeled. The most significant aerodynamic coupling effect introduced by close formation flight entails the coupling of the lateral/directional channel into

the altitude-hold autopilot channel. It is shown that formation hold autopilots designed ignoring the aerodynamic coupling effects, yield satisfactory performance in close formation flight.

DTIC

*Aerodynamic Forces; Aerodynamic Characteristics; Flight Control*

**19990045727** Air Force Inst. of Tech., School of Engineering, Wright-Patterson AFB, OH USA

**Multiple Model Adaptive Estimation Using Filter Spawning**

Fisher, Kenneth A.; Mar. 1998; 229p; In English

Report No.(s): AD-A361774; AFIT/EN/ENG/99M-09; No Copyright; Avail: CASI; A11, Hardcopy; A03, Microfiche

Multiple Model Adaptive Estimation with Filter Spawning is used to detect and estimate partial actuator failures on the VISTA F-16. The truth model is a full six-degree-of-freedom simulation provided by Calspan and General Dynamics. The design models are chosen as 13-state linearized models, including first order actuator models. Actuator failures are incorporated into the truth model and design model assuming a "failure to free stream". Filter Spawning is used to include additional filters with partial actuator failure hypotheses into the Multiple Model Adaptive Estimation (MMAE) bank. The spawned filters are based on varying degrees of partial failures (in terms of effectiveness) associated with the complete-actuator-failure hypothesis with the highest conditional probability of correctness at the current time. Thus, a blended estimate of the failure effectiveness is found using the filters' estimates based upon a no-failure hypothesis (or, an effectiveness of 100%), a complete actuator failure hypothesis (or, an effectiveness of 0%), and the spawned filters' partial-failure hypotheses. This yields substantial precision in effectiveness estimation, compared to what is possible without spawning additional filters, making partial failure adaptation a viable methodology in a manner heretofore unachieved.

DTIC

*Kalman Filters; F-16 Aircraft; Adaptive Control*

**19990046108** Air Force Systems Command, Wright-Patterson AFB, OH USA

**F-16 Stability and Control Certification Testing With Digital Flight Control System Improvements (or how we Learned to Manage Risk)**

Taschner, Michael J., Air Force Systems Command, USA; Janzen, Doyle B., Air Force Flight Test Center, USA; 1997 Report to the Aerospace Profession: Forty First Symposium Proceedings; Sep. 1997, pp. 290-306; In English; See also 19990046095; Copyright; Avail: Issuing Activity (Society of Experimental Test Pilots, Lancaster, CA), Hardcopy, Microfiche

Risk management lessons learned are presented from an Block 40/50 stability and control certification flight test program. Departure resistance enhancements significantly improved the maneuvering limits of the F-16 with large air-to-air missile lateral asymmetries. However post-departure characteristics following high-energy yaw departures proved problematic. Loadings with large lateral asymmetries and inlet pods demonstrated highly-dynamic upright spins. Deep stall recovery procedures were inadequate and on two occasions the spin chute was deployed to ensure aircraft recovery. Flight testing with inlet pods was suspended while test safety procedures were refined and an upright spin recovery procedure developed. The new procedures allowed successful completion of the program without further incident. Timeless risk management lessons were relearned in areas such as hazard identification risk assessment when performance is near ultimate achievable levels and developing viable risk control measures. Tough benefit-cost trade-offs were made to balance user requirements with flight test risk.

Author

*F-16 Aircraft; Flight Control; Stability; Flight Tests; User Requirements; Certification*

**19990046110** Royal Air Force, London, UK

**Meeting the UK's Future STOVL Recovery Requirements**

Paines, Justin, Royal Air Force, UK; Stone, Paul, Royal Navy, UK; 1997 Report to the Aerospace Profession: Forty First Symposium Proceedings; Sep. 1997, pp. 323-337; In English; See also 19990046095; Copyright; Avail: Issuing Activity (Society of Experimental Test Pilots, Lancaster, CA), Hardcopy, Microfiche

The UK's future STOVL recovery requirements are reviewed in the light of Harrier VSTOL operations and the impact of the Harrier's unique VSTOL capabilities. A description of the Vectored-thrust Aircraft Advanced Control programme and its background is followed by an account of the development and flight test of its major safety mechanism, the Independent Monitor (M). Various STOVL lessons learned are re-counted, with particular relevance to the renaissance in STOVL flight test which will



accompany the development of the Joint Strike Fighter (JSF) STOVL variant. These lessons include the impact of performance limitations on jet-borne flight test and the unpredictability of the partially jet-borne STOVL transition regime. The choices to be faced in the design of advanced STOVL flight control are considered along with the balance between the benefits of highly automated digital flight control for STOVL and potential loss in pilot flexibility. Plans for future research are reviewed.

Author

*Aircraft Control; Automatic Control; Digital Systems; Flight Control*

**19990046114** Flight Test Squadron (420th), Edwards AFB, CA USA

**B-2A Residual Pitch Oscillation (RPO) Investigation**

Moss, Christopher, Flight Test Squadron (420th), USA; Shifflett, Samuel, Flight Test Squadron (420th), USA; 1997 Report to the Aerospace Profession: Forty First Symposium Proceedings; Sep. 1997, pp. 393-410; In English; See also 19990046095; Copyright; Avail: Issuing Activity (Society of Experimental Test Pilots, Lancaster, CA), Hardcopy, Microfiche

In September of 1992, low altitude/high speed (LAHS) residual pitch oscillations (RPO) were first reported during a loads expansion test. During straight and level flight at 500 feet altitude with a forward center of gravity (cg), oscillations of 1.0 to 1.6 Hz frequency and + magnitude were observed, and a + 0.2g oscillation was observed during an airspace management turn. The magnitude of the oscillation seemed to be dependent on cg and Mach number. Increasing angle of attack (AOA) above trim also increased the magnitude of the oscillation. At the time, postnight analysis indicated the oscillations were most likely caused by aerodynamic and actuator characteristics that combined to reduce short period damping and stability margins. An actuator dead-band had been responsible for similar oscillations at high and medium altitudes, and those oscillations were eliminated with hardware and software modifications. An interim limit restricted forward cg at high airspeed until the damping could be improved. The oscillation was not considered to be possible flutter, as flutter testing had already cleared this Mach/altitude condition for all configurations. Later, it would be known that this oscillation was not only dependent on cg, but also outboard fuel loading and payload. Though the flutter clearance flights had thoroughly tested the LAHS regime, the aircraft configurations used, which flutter analysis had predicted to be the critical configurations, were not conducive to RPO. As a result, flutter testing only saw small oscillations that were attributed to the same actuator non-linearity.

Author

*Oscillations; Research; B-2 Aircraft; Aerodynamic Characteristics; Angle of Attack; Center of Gravity; Flutter Analysis*

**19990046435** NASA Dryden Flight Research Center, Edwards, CA USA

**Simulator Evaluation of Simplified Propulsion-Only Emergency Flight Control Systems on Transport Aircraft**

Burcham, Frank W., Jr., NASA Dryden Flight Research Center, USA; Kaneshige, John, NASA Ames Research Center, USA; Bull, John, Caelum Research Corp., USA; Maine, Trindel A., NASA Dryden Flight Research Center, USA; June 1999; 49p; In English Contract(s)/Grant(s): RTOP 522-35-14

Report No.(s): NASA/TM-1999-206578; NAS 1.15:206578; H-2331; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

With the advent of digital engine control systems, considering the use of engine thrust for emergency flight control has become feasible. Many incidents have occurred in which engine thrust supplemented or replaced normal aircraft flight controls. In most of these cases, a crash has resulted, and more than 1100 lives have been lost. The NASA Dryden Flight Research Center has developed a propulsion-controlled aircraft (PCA) system in which computer-controlled engine thrust provides emergency flight control capability. Using this PCA system, an F-15 and an MD-11 airplane have been landed without using any flight controls. In simulations, C-17, B-757, and B-747 PCA systems have also been evaluated successfully. These tests used full-authority digital electronic control systems on the engines. Developing simpler PCA systems that can operate without full-authority engine control, thus allowing PCA technology to be installed on less capable airplanes or at lower cost, is also a desire. Studies have examined simplified ?PCA Ultralite? concepts in which thrust control is provided using an autothrottle system supplemented by manual differential throttle control. Some of these concepts have worked well. The PCA Ultralite study results are presented for simulation tests of MD-11, B-757, C-17, and B-747 aircraft.

Author

*Flight Control; Simulators; Transport Aircraft; Digital Systems; Engine Control; Thrust Control*

## RESEARCH AND SUPPORT FACILITIES (AIR)

*Includes airports, hangars and runways; aircraft repair and overhaul facilities; wind tunnels; shock tubes; and aircraft engine test stands.*

**19990045708** NASA Marshall Space Flight Center, Huntsville, AL USA

### **Uncertainty Analysis of the NASA MSFC 14-inch Trisonic Wind Tunnel**

Springer, Anthony M., NASA Marshall Space Flight Center, USA; Walker, Holly J., NASA Marshall Space Flight Center, USA; Frost, Alonzo, NASA Marshall Space Flight Center, USA; 1999; In English; Aerospace Sciences, 11-14 Jan. 1999, Reno, NV, USA; Sponsored by American Inst. of Aeronautics and Astronautics, USA

Contract(s)/Grant(s): X-33/242-22/EZ

Report No.(s): AIAA Paper 99-0684; Copyright; Avail: Issuing Activity, Hardcopy, Microfiche

An uncertainty analysis was performed on the NASA MSFC 14-inch trisonic wind tunnel using the AIAA standard for the assessment of wind tunnel data uncertainty and the methodology presented in the AGARD report 'Quality Assessment for Wind Tunnel Testing.' This analysis shows what the major contributing factors to the overall data uncertainty of the resultant wind tunnel data are and how these contributing factors can be reduced. The basic analysis was performed for the facility operational parameters, flow conditions, and then the effects over the Mach range of 0.3 to 5.0 on the final aerodynamic data coefficients. The effects of changing accuracy, conditions, precision, and biases at the various Mach numbers were analyzed. The analysis was performed for two main systems the facility flow conditions mentioned above and the model instrumentation including the strain gauge balance, pressure system, and supporting instrumentation. A detailed analysis of the strain gauge balance is not presented. This analysis serves as a reference for the 14-inch wind tunnels customers, users and other facilities undertaking an analysis of their facilities.

Author

*Accuracy; Aerodynamics; Measuring Instruments; Trisonic Wind Tunnels*

**19990045720** Air Force Inst. of Tech., School of Engineering, Wright-Patterson AFB, OH USA

### **Development of Site Characterization Simulator**

Kassel, Neil W.; Mar. 1999; 124p; In English

Report No.(s): AD-A361724; AFIT/GEE/ENG/99M-01; No Copyright; Avail: CASI; A06, Hardcopy; A02, Microfiche

The purpose of this study was to develop a tool for Remedial Project Managers (RPMs) to learn and practice the site characterization process. One of the key difficulties encountered by RPMs during site characterization is the need to develop a model of the site based on limited data. These limited data are used to determine parameters that describe hydrogeologic and contaminant properties (aquifer hydraulic conductivity, contaminant concentration, etc.) and are obtained using sampling techniques that interrogate a very small volume, usually much smaller than node spacing of the computer model used to simulate site conditions. The value of the parameter being measured in the field and used in modeling the site is therefore a function of both the sampling location and the volume (of water, aquifer) interrogated. This research identified techniques to incorporate the impact of spatial variability and sampling method (particularly, sampling volume and method error) in a site characterization simulator.

DTIC

*Computerized Simulation; Spatial Distribution; Models; Aquifers*

**19990045814** Naples Univ., Italy

### **The Study of Aircraft Trajectory on Airport Surfaces**

Tocchetti, Andrea, Naples Univ., Italy; Bruno, Vincenzo, Naples Univ., Italy; deRisodiCarpinone, Vittorio, Naples Univ., Italy; The Conference Proceedings of the 1998 Air Transport Research Group (ATRG) of the WCTR Society; December 1998; Volume 1; 18p; In English; See also 19990045796; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

A study the maneuvering of an aircraft through a curve in the runway is described. The problem of studying a geometry of exit paths was undertaken so that the aircraft trajectory while taxiing can be made more secure, and at the same time improve the traffic capacity of the runway.

CASI

*Airports; Runways; Taxiing; Airfield Surface Movements; Runway Conditions; Trajectories*

**19990045904** NASA Johnson Space Center, Houston, TX USA

### **Ellington Field: A Short History, 1917-1962**

Carlson, Erik, NASA Johnson Space Center, USA; Feb. 1999; 56p; In English

Report No.(s): NASA/CR-1999-208921; NAS 1.26:208921; No Copyright; Avail: CASI; A04, Hardcopy; A01, Microfiche

This document details the chronological history of an air field in Southeast Texas that currently serves as an adjunct to NASA Johnson Space Center as well as a civilian/military air field. The field was built early in the 20th century, soon after airplane flight became a recognized factor in American military applications, was central to a wide variety of military uses throughout this century, and remains viable for such purposes in addition to serving a vital role in NASA's training of astronauts.

Author

*Airports; Military Aircraft; Aircraft Design; Pilots; Airport Planning*

**19990046017** National Aerospace Lab., Tokyo Japan

**Starting Loads in Supersonic Engine Wind Tunnels**

Sakuranaka, N.; Shimura, T.; Mitani, T.; Izumikawa, M.; Tomioka, S.; Oct. 1998; 30p; In Japanese; Portions of this document are not fully legible

Report No.(s): PB99-141558; NAL-TR-1360; Copyright; Avail: National Technical Information Service (NTIS), Microfiche

Starting loads, which are especially severe in free-jet type engine wind tunnels, were investigated in order to carry out accurate and safe force measurement. Unsteady pressures and forces were measured and analyzed by fast Fourier transform (FFT). Expected maximum peak load of the Ramjet Engine Test Facility (FJTF) was predicted from power spectral density and probability distribution using the results of a pilot wind tunnel test. Visual observation was also conducted and combined with the results of unsteady pressure measurement to clarify the cause of the large starting loads. The cause was considered to be the flow structure in which nozzle flow is recompressed by a separation oblique-shock wave and impinges on the model installed on a force measuring system (FMS).

NTIS

*Test Facilities; Supersonic Wind Tunnels; Fast Fourier Transformations; Loads (Forces)*

**19990046213** National Aerospace Lab., Tokyo Japan

**Estimating Aerodynamic Characteristics of the ALFLEX Vehicle Using Flight Test Data and Comparison with Wind Tunnel Test Data**

Yanagihara, M.; Shigemi, M.; Suito, T.; Jul. 1998; 40p; In Japanese; Portions of this document are not fully legible

Report No.(s): PB99-141517; NAL-TR-1353; Copyright; Avail: National Technical Information Service (NTIS), Microfiche

One of the purposes of the Automatic Landing Flight Experiment (ALFLEX) is to estimate the aerodynamic characteristics of a vehicle with a delta wing and tip fins. The tests for this purpose, such as alpha and beta sweep tests and control surface excitation test, were conducted during the hanging flights and automatic landing flights. By analyzing the flight test data obtained at the Woomera test site in Australia, the aerodynamic characteristics of the ALFLEX vehicle were estimated and the results were compared with one predicted by several wind tunnel tests. As a result, the differences between the estimated characteristics and the results of the basic wind tunnel test were within the variation. Some other wind tunnel tests, however, showed significantly different results from the flight tests. These differences seemed to be caused by errors of the wind tunnel tests due to, for example, the effect of the supporting device.

NTIS

*Aerodynamic Characteristics; Wind Tunnel Tests; Flight Tests; Control Surfaces*

## 12 ENGINEERING

*Includes engineering (general); communications and radar; electronics and electrical engineering; fluid mechanics and heat transfer; instrumentation and photography; lasers and masers; mechanical engineering; quality assurance and reliability; and structural mechanics.*

**19990045699** Department of Energy, Office of Financial Management and Controller, Washington, DC USA

**Turbomachinery blade optimization using the Navier-Stokes equations**

Chand, K. K.; Lee, K. D.; Dec. 01, 1997; 14p; In English; American Institute of Aeronautics and Astronautics (AIAA) sciences meeting

Report No.(s): DE98-054342; UCRL-JC-129284; No Copyright; Avail: Department of Energy Information Bridge, Microfiche

A method is presented to perform aerodynamic design optimization of turbomachinery blades. The method couples a Navier-Stokes flow solver with a grid generator and numerical optimization algorithm to seek improved designs for transonic turbine blades. A fast and efficient multigrid, finite-volume flow solver provides accurate performance evaluations of potential designs. Design variables consist of smooth perturbations to the blade surface. A unique elliptic-hyperbolic grid generation method is used

to regenerate a Navier-Stokes grid after perturbations have been added to the geometry. Designs are sought which improve a design objective while remaining within specified constraints. The method is demonstrated with two transonic turbine blades with different types and numbers of design variables.

NTIS

*Aerodynamics; Optimization; Supersonic Turbines; Turbine Blades; Navier-Stokes Equation*

**19990046446** NASA Langley Research Center, Hampton, VA USA

**Ferroelectric Stirling-Cycle Refrigerator**

Jalink, Antony, Jr., Inventor, NASA Langley Research Center, USA; Hellbaum, Richard F., Inventor, NASA Langley Research Center, USA; Rohrbach, Wayne W., Inventor, NASA Langley Research Center, USA; Feb. 09, 1999; In English

Patent Info.: Filed 3 Apr. 1997; NASA-Case-LAR-15664-1; US-Patent-5,867,991; US-Patent-Appl-SN-840111; No Copyright; Avail: US Patent and Trademark Office, Hardcopy, Microfiche

A Stirling-cycle refrigerator has a three-pump configuration and pumping sequence, in which one pump serves as a compressor, one pump serves as an expander, and one pump serves as a displacer. The pumps are ferroelectrically actuated diaphragm pumps which are coordinated by synchronizing the ferroelectric-actuator voltages in such a way that the net effect of the displacer is to reduce the deleterious effect of dead space; that is, to circulate a greater fraction of the working fluid through the heat exchangers than would be possible by use of the compressor and expander alone. In addition, the displacer can be controlled separately to make the flow of working fluid in the heat exchangers turbulent (to increase the rate of transfer of heat at the cost of greater resistance to flow) or laminar (to decrease the resistance to flow at the cost of a lower heat-transfer rate).

Official Gazette of the U.S. Patent and Trademark Office

*Compressors; Ferroelectricity; Heat Exchangers; Heat Transfer; Refrigerators; Stirling Cycle; Cryogenic Cooling; Cryogenic Equipment; Cryogenics; Low Temperature; Pumps*

**19990046064** NASA Langley Research Center, Hampton, VA USA

**Design and Development of Lateral Flight Director**

Kudlinski, Kim E., NASA Langley Research Center, USA; Ragsdale, William A., Unisys Corp., USA; May 1999; 78p; In English  
Contract(s)/Grant(s): RTOP 992-30-11

Report No.(s): NASA/TM-1999-208957; L-17781; NAS 1.15:208957; No Copyright; Avail: CASI; A05, Hardcopy; A01, Microfiche

The current control law used for the flight director in the Boeing 737 simulator is inadequate with large localizer deviations near the middle marker. Eight different control laws are investigated. A heuristic method is used to design control laws that meet specific performance criteria. The design of each is described in detail. Several tests were performed and compared with the current control law for the flight director. The goal was to design a control law for the flight director that can be used with large localizer deviations near the middle marker, which could be caused by winds or wake turbulence, without increasing its level of complexity.

Author

*Instrument Landing Systems; Boeing 737 Aircraft; Control Systems Design; Flight Control; Flight Simulators; Control Theory*

**19990046028** General Electric Co., Schenectady, NY USA

**Annular flow of R-134a through a high aspect ratio duct: Local void fraction, droplet velocity and droplet size measurements**

Trabold, T. A.; Kumar, R.; Vassallo, P. F.; Nov. 30, 1998; 39p; In English; 1998 international mechanical engineering congress and exposition

Report No.(s): DE99-001457; KAPL-P-000071; K-98042; No Copyright; Avail: Department of Energy Information Bridge, Microfiche

Local measurements were made in annular flow of R-134a through a vertical duct. Using a gamma densitometer, hot-film anemometer and laser Doppler velocimeter, profiles of void fraction, liquid droplet frequency and droplet velocity were acquired across the narrow test section dimension. Based upon these results, data for liquid droplet size were obtained and compared to previous experimental results from the literature. These data are useful for developing an improved understanding of practical two-phase refrigerant flows, and for assessment of advanced two-fluid computer codes.

NTIS

*Annular Flow; High Aspect Ratio; Voids; Velocity Measurement; Drops (Liquids); Drop Size*

**19990046378** Naval Postgraduate School, Monterey, CA USA

**Observed Kinematics of Waves in the Surf Zone**

Constantian, Richard K., Jr; Mar. 1999; 53p; In English

Report No.(s): AD-A361813; No Copyright; Avail: CASI; A04, Hardcopy; A01, Microfiche

The observed kinematics of waves in the surf zone is examined with extensive measurements from the DUCK94 experiment. Field data used in the study were obtained from vertical stacks of bi-directional current meters and a pressure sensor mounted on a rigid frame at 3 locations along a cross-shore transect in depths of 2, 4, and 8m. Observed pressure and velocity spectra are compared to transfer functions based on linear finite depth theory and a simple nonlinear model that accounts for harmonic generation in shallow water. At high frequencies, the observed vertical attenuation of horizontal velocity spectra in 8 and 4m depth is much weaker than predicted by linear theory and generally in good agreement with the nonlinear model predictions. In 2m depth, differences between the linear and nonlinear transfer function are small and both predictions are in reasonable agreement with the observed weak vertical decay. At infragravity frequencies in shallow water depths, observed velocity spectra often show significant vertical decay that is not predicted by either model. Velocity and pressure spectra measured in 4m depth are in good agreement with the nonlinear transfer function. Pressure spectra levels at high frequencies are shown to be significantly reduced by the nonlinear Bernoulli term in the second order pressure field. Analysis of the slopes of the high-frequency tails of the observed velocity spectra shows considerable scatter with a general tendency for spectra to flatten as waves rotate through the surf zone.

DTIC

*Waves; Kinematics; Tail Assemblies*

**19990046783** NASA Langley Research Center, Hampton, VA USA

**Process for Making Carbon-Carbon Turbocharger Housing Unit for Intermittent Combustion Engines**

Northam, G. Burton, Inventor, NASA Langley Research Center, USA; Ransone, Philip O., Inventor, NASA Langley Research Center, USA; Rivers, H. Kevin, Inventor, NASA Langley Research Center, USA; May 04, 1999; In English; Division of US-Patent-Appl-SN-811378, filed 4 Mar. 1997 and Provisional Application of US-Patent-Appl-SN-012940, filed 6 Mar. 1996

Patent Info.: Filed 3 Nov. 1997; NASA-Case-LAR-15496-2; US-Patent-5,900,089; US-Patent-Appl-SN-963291; US-Patent-Appl-SN-811378; US-Patent-Appl-SN-012940; No Copyright; Avail: US Patent and Trademark Office, Hardcopy, Microfiche

An improved, lightweight, turbine housing unit for an intermittent combustion reciprocating internal combustion engine turbocharger is prepared from a lay-up or molding of carbon-carbon composite materials in a single-piece or two-piece process. When compared to conventional steel or cast iron, the use of carbon-carbon composite materials in a turbine housing unit reduces the overall weight of the engine and reduces the heat energy loss used in the turbo-charging process. This reduction in heat energy loss and weight reduction provides for more efficient engine operation.

Official Gazette of the U.S. Patent and Trademark Office

*Turbocompressors; Carbon-Carbon Composites; Housings; Superchargers; Iron Alloys*

**13**

**GEOSCIENCES**

*Includes geosciences (general); earth resources and remote sensing; energy production and conversion; environment pollution; geophysics; meteorology and climatology; and oceanography.*

**19990045779** Physics and Electronics Lab. TNO, The Hague, Netherlands

**Geographical Information Extraction with Remote Sensing, Part 2, Technical Supplement**

vandenBroek, A. C., Physics and Electronics Lab. TNO, Netherlands; vanPersie, M., Physics and Electronics Lab. TNO, Netherlands; Noorbergen, H. H. S., Physics and Electronics Lab. TNO, Netherlands; Rijckenberg, G. J., Physics and Electronics Lab. TNO, Netherlands; August 1998; 1p; In English; Original contains color illustrations

Report No.(s): FEL-98-A077-Pt-2; Copyright; Avail: Issuing Activity (TNO Physics and Electronics Lab., Oude Waalsdorperweg 63, PO Box 96864, 2509 JG The Hague, The Netherlands), Hardcopy, Microfiche

In this part of the report we give details about the sensors and platforms used. We furthermore describe extraction and visualisation techniques. Imaging sensors operating in three wavelength regions are considered: (1) optical/near-infrared; (2) thermal infrared; and (3) microwave. The sensors are mounted on a so-called platform. We discriminate here between airborne and spaceborne platforms. Spaceborne platforms are always called satellites, while airborne platforms can be conventional aircrafts, but also UAV's, drones or even balloons. Main difference between space and airborne platforms is the distance between the sensor and the Earth surface, which ranges roughly from 100 km to 36,000 km for spaceborne and 10 meter to 20 km for airborne systems. The distance influences the information content of an image, especially the resolution and the imaging geometry. We will discuss



here the resolution and imaging geometry in a general context. In the next sections we will discuss for the three wavelength domains the following topics in more detail: (1) physical background; (2) imaging geometry and image distortions; and (3) present and future systems.

Derived from text

*Space Platforms; Remote Sensing; Imaging Techniques; Flying Platforms*

**19990046022** Jet Propulsion Lab., California Inst. of Tech., Pasadena, CA USA

**The Role of HO(x) in Super- and Subsonic Aircraft Exhaust Plumes**

Hanisco, T. F., Harvard Univ., USA; Wennberg, P. O., Harvard Univ., USA; Cohen, R. C., Harvard Univ., USA; Anderson, J. G., Harvard Univ., USA; Fahey, D. W., National Oceanic and Atmospheric Administration, USA; Keim, E. R., National Oceanic and Atmospheric Administration, USA; Gao, R. S., National Oceanic and Atmospheric Administration, USA; Wamsley, R. C., National Oceanic and Atmospheric Administration, USA; Donnelly, S. G., National Oceanic and Atmospheric Administration, USA; DelNegro, L. A., National Oceanic and Atmospheric Administration, USA; Salawitch, R. J., Jet Propulsion Lab., California Inst. of Tech., USA; Kelly, K. K., National Oceanic and Atmospheric Administration, USA; Proffitt, M. H., National Oceanic and Atmospheric Administration, USA; *Geophysical Research Letters*; Jan. 01, 1997; ISSN 0094-8534; Volume 24, No. 1, pp. 65-68; In English

Report No.(s): Paper-96GL03724; Copyright; Avail: Issuing Activity, Hardcopy, Microfiche

The generation of sulfuric acid aerosols in aircraft exhaust has emerged as a critical issue in determining the impact of supersonic aircraft on stratospheric ozone. It has long been held that the first step in the mechanism of aerosol formation is the oxidation of SO<sub>2</sub>, emitted from the engine by OH in the exhaust plume. We report in situ measurements of OH and HO, in the exhaust plumes of a supersonic (Air France Concorde) and a subsonic (NASA ER-2) aircraft in the lower stratosphere. These measurements imply that reactions with OH are responsible for oxidizing only a small fraction of SO<sub>2</sub> (2%), and thus cannot explain the large number of particles observed in the exhaust wake of the Concorde.

Author

*Exhaust Gases; Oxidation; Sulfur Dioxides; Sulfuric Acid; Supersonic Aircraft; Stratosphere; Jet Exhaust; Exhaust Emission*

## 14 LIFE SCIENCES

*Includes life sciences (general); aerospace medicine; behavioral sciences; man/system technology and life support; and space biology.*

**19990046023** Civil Aeromedical Inst., Oklahoma City, OK USA

**Formation of an Interfering Substance, 3, 4-Dimethyl-5-Phenyl-1, 3-Oxazolidine, During A Pseudoephedrine Urinalysis**

Lewis, Russell J., Civil Aeromedical Inst., USA; Huffine, Edwin F., Civil Aeromedical Inst., USA; Chaturvedi, Arvind K., Civil Aeromedical Inst., USA; Canfield, Dennis V., Civil Aeromedical Inst., USA; Mattson, Jerry, Civil Aeromedical Inst., USA; May 1999; 14p; In English

Contract(s)/Grant(s): AM-B-98-TOX-202

Report No.(s): DOT/FAA/AM-99/15; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

During fatal aviation accident investigations, bio-samples from the victims are submitted to the FAA Civil Aeromedical Institute for drug analysis. In the process of one such analysis, an unknown substance was found in a urine sample. Its initial analyses by thin layer chromatography and by liquid-liquid extraction/gas chromatography (GC) disclosed the presence of pseudoephedrine. Subsequent analyses of the reaccessioned sample by solid phase separation/GC Fourier transform infrared/GC mass spectrometry indicated that the retention times of the unknown substance matched with those of pseudoephedrine. However, its infrared and mass spectra were different--the -OH and -NH- groups were missing, a C-O-C group was present, and the molar mass was 12 atomic mass units (amu) more than that of pseudoephedrine. A subsequent literature search suggested that ephedrine-like amines react with aldehydes to form oxazolidines. Therefore, the 12-amu increase could be accounted for by condensation of pseudoephedrine with formaldehyde. Since this aldehyde is present in various grades of methanol, and methanol was used during the solid phase separation, 3,4-dimethyl-5-phenyl-1,3-oxazolidine was synthesized by using +/- pseudoephedrine.HCl and formaldehyde. The analytical and spectral findings of the synthesized compound were consistent with those of the unknown interfering substance, confirming that it was the oxazolidine. Aldehyde contaminants can transform the drug of interest and may result in misidentification of a compound not originally present in specimens. Therefore, chemicals used in analyses should be of the highest available purity, and a multi-analytical approach should be adopted to maintain a high degree of quality assurance.

Author

*Aircraft Accident Investigation; Aircraft Accidents; Gas Chromatography; Thin Layer Chromatography; Urinalysis*



**19990046433** Cincinnati Univ., OH USA

**Female Reproductive Effects of Exposure to Jet Fuel at U.S. Air Force Bases** *Annual Report, 15 Oct. 1997 - 14 Oct. 1998*

Lemasters, Grace K.; Nov. 1998; 38p; In English

Contract(s)/Grant(s): DAMD17-96-2-6015

Report No.(s): AD-A361885; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

One of the most prevalent exposures at all Air Force (AF) bases is to jet fuel. Total consumption ranks in the billions of gallons. Jet fuel is composed of aliphatic/aromatic hydrocarbons and traces of metals that have potential adverse effects on health including menstrual disorders, infertility, spontaneous abortions, and fetal effects. The mean age of active enlisted female Air Force personnel is 27.6. This study addresses whether or not women are experiencing menstrual systems related to their work place from fuel exposures. This study evaluates environmental and internal dose measurements of jet fuel components during the course of each woman's usual work activities. Great strides have been made thus far. The number of women in pertinent job activities at each base has been identified and base commanders have received letters of request. Ten bases, thus far, have agreed to participate and have been visited. We have enrolled 165 women into the study. This team also developed and refined a new technique to measure internal dose levels. Specifically, the breath data indicates concentrations of toluene and the xylenes to range in concentrations between 10 and over 100 ppb.

DTIC

*Exposure; Females; Personnel; Jet Engine Fuels; Menstruation; Reproduction*

**19990045792** Civil Aviation Authority, Gatwick, UK

**Human Factors in Maintenance**

Hall, David, Civil Aviation Authority, UK; 1998; In English; See also 19990045788

Report No.(s): Paper-6; Copyright; Avail: Issuing Activity (The Royal Aeronautical Society, 4 Hamilton Place, London, W1V 0BQ, UK), Hardcopy, Microfiche

The aviation maintenance community have been rather late on the scene regarding human factors. Pilots and Air traffic controllers, along with their immediate environment have been subject of ergonomic study since at least World War Two. As far back as then it was established that 70% of aircraft accidents are attributable in some way to human error. This figure has not changed over the years, and could in fact be as high as 80% today. It is now internationally recognized that improvements in aircraft technology are unlikely to provide the necessary improvements in air safety that are being demanded in the face of increasing air traffic. In June 1990 the importance of human factors in maintenance was brought to the fore in the UK when a windscreen blew out of a BAC1-11 and landed in an Oxfordshire field. Since that time other near fatal accidents have occurred which has brought about the Civil Aviation Authority (CAA)'s and industry's acceptance of the importance of human factors in aircraft maintenance. A number of initiatives are now underway to increase awareness and apply human factors principles in the workplace.

Derived from text

*Aircraft Maintenance; Aircraft Safety; Human Factors Engineering; Human Performance; Flight Safety*

**19990045793** Civil Aviation Authority, Safety Regulation Group, Gatwick, UK

**Human Error Tolerance in Helicopter Cockpit Systems**

Courteney, Hazel, Civil Aviation Authority, UK; Rotorcraft Flight Safety: Proceedings; 1998; In English; See also 19990045788

Report No.(s): Paper-7; Copyright; Avail: Issuing Activity (The Royal Aeronautical Society, 4 Hamilton Place, London, W1V 0BQ, UK), Hardcopy, Microfiche

This paper is aimed at helicopter operators who may be considering new cockpit equipment fits. It is intended to raise awareness of the effect that such systems can have on flight safety, because of their relationship to crew performance, and the possibility of error. One way to approach this is to identify the most important risk areas, then review the effects - positive and negative that the new system could have in these respects. The paper will begin by identifying the main risk areas for UK helicopter operations. An analysis of recent Mandatory Occurrence Reports (MORs) is presented. Comparisons will be made between different categories of operators and between MOR events caused by technical versus human causal factors. It will be suggested that the greater risks currently lie with helicopter operations that are outside the Police / Ambulance (P/A) and other Public Transport (PT) categories, and with those events that arise from human - as opposed to technical - causes, although these are the minority of MORs. New cockpit technologies are likely to be available for helicopters within the next five years, for example, Flight Management Systems (FMS) that are comparable to their fixed wing counterparts. Drawing on the findings of the MOR analysis, and some feedback from fixed wing operators of FMS, suggestions will be made concerning the effects that such systems could have on

helicopter flight safety. Finally, CAA activity to address the crew related aspects of light deck design in Type certification will be outlined.

Author

*Cockpits; Helicopters; Human Performance; Aircraft Equipment; Flight Instruments; Human Factors Engineering; Flight Safety; Safety Devices*

## 15

### MATHEMATICAL AND COMPUTER SCIENCES

*Includes mathematical and computer sciences (general); computer operations and hardware; computer programming and software; computer systems; cybernetics; numerical analysis; statistics and probability; systems analysis; and theoretical mathematics.*

**19990044098** Air Force Inst. of Tech., School of Engineering, Wright-Patterson AFB, OH USA

#### **Loop Gain Estimation for Adaptive Control**

Sillence, Jamey P.; Mar. 1999; 101p; In English

Report No.(s): AD-A361718; AFIT/GE/ENG/99M-27; No Copyright; Avail: CASI; A06, Hardcopy; A02, Microfiche

The identification of a linear discrete-time control system's loop gain is addressed. The classical Kalman filter theory for state estimation in linear control systems is extended, and the control system's loop gain and state are jointly estimated. A rigorous analysis of the measurement situation under consideration yields explicit formulae for the loop gain's unbiased estimate and estimation error's covariance.

DTIC

*Flight Control; Adaptive Control; Covariance; Identifying*

## 16

### PHYSICS

*Includes physics (general); acoustics; atomic and molecular physics; nuclear and high-energy; optics; plasma physics; solid-state physics; and thermodynamics and statistical physics.*

**19990046590** General Electric Co., Aircraft Engines, Cincinnati, OH USA

#### **Acoustic Treatment Design Scaling Methods, Volume 2, Advanced Treatment Impedance Models for High Frequency Ranges**

Kraft, R. E., General Electric Co., USA; Yu, J., Rohr Industries, Inc., USA; Kwan, H. W., Rohr Industries, Inc., USA; April 1999; 98p; In English

Contract(s)/Grant(s): NAS3-26617; RTOP 538-03-12-02

Report No.(s): NASA/CR-1999-209120/VOL2; NAS 1.26:209120/VOL2; No Copyright; Avail: CASI; A05, Hardcopy; A02, Microfiche

The primary purpose of this study is to develop improved models for the acoustic impedance of treatment panels at high frequencies, for application to subscale treatment designs. Effects that cause significant deviation of the impedance from simple geometric scaling are examined in detail, an improved high-frequency impedance model is developed, and the improved model is correlated with high-frequency impedance measurements. Only single-degree-of-freedom honeycomb sandwich resonator panels with either perforated sheet or "linear" wiremesh faceplates are considered. The objective is to understand those effects that cause the simple single-degree-of-freedom resonator panels to deviate at the higher-scaled frequency from the impedance that would be obtained at the corresponding full-scale frequency. This will allow the subscale panel to be designed to achieve a specified impedance spectrum over at least a limited range of frequencies. An advanced impedance prediction model has been developed that accounts for some of the known effects at high frequency that have previously been ignored as a small source of error for full-scale frequency ranges.

Author

*Acoustic Impedance; High Frequencies; Aircraft Models; Scale Models; Aircraft Noise; Noise Prediction (Aircraft); Aeroacoustics*

**19990046608** NASA Langley Research Center, Hampton, VA USA

**Inlet Noise Reduction by Shielding for the Blended Wing-Body Airplane**

Clark, Lorenzo R., NASA Langley Research Center, USA; Gerhold, Carl H., NASA Langley Research Center, USA; 1999; In English; Aeroacoustics, 10-12 May 1999, Seattle, WA, USA

Report No.(s): AIAA Paper 99-1937; Copyright; Avail: Issuing Activity, Hardcopy, Microfiche

Noise shielding benefits associated with an advanced unconventional subsonic transport concept, the Blended-Wing-Body, were studied using a 4-percent scale, 3-engine nacelle model. The study was conducted in the Anechoic Noise Research Facility at NASA Langley Research Center. A high-frequency, wideband point source was placed inside the nacelles of the center engine and one of the side engines in order to simulate broadband engine noise. The sound field of the model was measured with a rotating microphone array that was moved to various stations along the model axis and with a fixed array of microphones that was erected behind the model. Ten rotating microphones were traversed a total of 22 degrees in 2-degree increments, Seven fixed microphones covered an arc that extended from a point in the exhaust exit plane of the center engine (and directly below its centerline) to a point 30 degrees above the jet centerline. While no attempt was made to simulate the noise emission characteristics of an aircraft engine, the model source was intended to radiate sound in a frequency range encompassing 1, 2, and 3 times the blade passage of a typical full-scale engine. In this study, the Blended-Wing-Body model was found to provide significant shielding of inlet noise. In particular, noise radiated downward into the forward sector was reduced by 20 to 25 dB overall in the full-scale frequencies from 2000 to 4000 Hz, decreasing to 10 dB or less at the lower frequencies. Also, it was observed that noise associated with the exhaust radiates into the sector directly below the model downstream to reduce shielding efficiency.

Author

*Body-Wing Configurations; Aerodynamic Noise; Aircraft Noise; Engine Noise; Engine Inlets; Nacelles*

**19990045762** Department of Energy, Washington, DC USA

**Accident analysis for aircraft crash into hazardous facilities: A statistical primer**

Rock, J. C.; Dec. 31, 1998; 26p; In English

Report No.(s): DE99-000456; ANRCP-1998-20; No Copyright; Avail: Department of Energy Information Bridge, Microfiche

The DOE Standard 3014-96, Accident Analysis for Aircraft Crash into Hazardous Facilities provides a robust statistical framework useful for assessing the release frequency for hazardous materials used in many industrial operations. The formulae and the verbal instructions for calculating screening quantities and frequencies in the DOE Standard are consistent with an unstated underlying six-term expression for estimating the annual number of aircraft- impact-related releases. The six-term formula is here shown to result from iterated application of Bayes' rule. The statistical concepts underlying this formula are explained; the six-term model is then developed and its components related to the corresponding elements of the four-factor model presented in the Standard. The six-term model is shown to be consistent with the instructions given in the Standard for calculating the screening and evaluation quantities using the four-factor model. The difference between screening and evaluation of release frequencies is clarified. Discussion of the six-term model shows clearly how conservative approximations to its conditional probability terms lead to simple and efficient screening formulae. A numerical example is provided to demonstrate a screening calculation.

NTIS

*Aircraft Accidents; Hazardous Materials; Probability Theory; Aircraft Accident Investigation*

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